University of Alberta

Sensory and Instrumental Evaluations of Saskatoon Fruit

by

Kylie Nance Kidd ©

A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science
in
Food Science and Technology

Department of Agricultural, Food and Nutritional Science

Edmonton, Alberta
Fall, 2006

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Your file Votre référence
ISBN: 978-0-494-22297-3
Our file Notre référence
ISBN: 978-0-494-22297-3

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ABSTRACT

Saskatoon fruit (*Amelanchier alnifolia* Nutt.), an anthocyanin-rich crop, is consumed throughout the Canadian prairies during its short season. Sensory and instrumental evaluations were used to assess quality changes in fruit from 3 commercially produced cultivars ('Thiessen', 'Northline', and 'Smoky') over 5 d of storage at 4 °C. The unstored (0 d) fruit descriptive profiles were useful in assessing quality changes over the 5 d. Initial juiciness of fruit from each cultivar perceivably increased ($p \leq 0.05$) after 3 d. After 5 d, the sour intensity of fruit from 'Northline' declined ($p \leq 0.05$) and the firmness and astringency of fruit from 'Thiessen' increased ($p \leq 0.05$). Although 'Smoky' was preferred ($p \leq 0.05$) over 'Thiessen', consumers' overall opinions of fruit from each cultivar declined ($p \leq 0.05$) within 3 d. Local consumers' expectations of the sensory attributes of saskatoon fruit appear to be based on past experiences with 'wild' fruit.

ACKNOWLEDGMENTS

I would like to extend my sincerest appreciation to all those who have contributed to the completion of my research. First and foremost, I would like to thank my supervisors, Dr. Wendy Wismer and Dr. Jocelyn Ozga, for their support and guidance over the past 3 years. I would like to thank the remaining committee members Dr. Lynn McMullen, for her unwavering confidence in me and support throughout my undergraduate and graduate studies, and Dr. Peter Boxall, for the insightful perspective he contributed to the committee. I would like to acknowledge the hard work of Michael Seibel in his contribution to the development of the saskatoon fruit descriptive profiles. I would like to express my gratitude to all the technical staff (Laki Goonewardene, Gabe Botar, Kelvin Lien, Susan Gibson, and Jean Bourgois) for their knowledge and assistance, and the summer students (Saleem, Mason, Lucy, Wei, and Kausal) for their hard work. In recognition of their appreciation and support of this research, a big thank-you to Del and Gerry Tobert and the fruit pickers at Treeberry Farms and Hole's Greenhouse & Garden Centre. Lastly, I would like to thank my fellow graduate students and co-workers who have made the last 3 years a time in my life to look back on with a smile.

DEDICATION

For Cheyney and my family, for their love and support

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LIST OF ABBREVIATIONS

DA	**Descriptive Analysis**
SEM	**Standard Error of the Mean**
R1	**Lower Intensity Reference Standard**
R2	**Higher Intensity Reference Standard**
SSC	**Soluble Solids Content**
TA	**Titratable Acidity**
SSC/TA	**Sugar-to-Acid**
L	**Lightness**
C	**Chroma**
h°	**Hue Angle**
OSFI	**Overall Saskatoon Flavor Intensity**
MAP	**Modified Atmosphere Packaging**

1. Introduction

1.1 Background

Saskatoon fruit (*Amelanchier alnifolia* Nutt.), also referred to as serviceberry, western shadbush, juneberry, or Rocky Mountain blueberry, is a small fruit crop native to the southern Yukon and Northwest Territories, the Canadian Prairies, and parts of California, Arizona, New Mexico, Nebraska, and North and South Dakota states of the United States (Harris 1972; St. Pierre 1992). Saskatoon fruit bushes adapt well to a wide range of soil types and climate conditions; as a wild fruit it was a staple in the diet of early settlers and native Americans and was an important food source during the drought and depression in the 1930's. Although commonly referred to as a berry, the saskatoon is in fact a pome fruit like apples, pears, and quinces.

Cultivars of saskatoon fruit for commercial production were selected from wild plants based on resistance to diseases, high yields, and fruit quality (flavor, color, and texture) (St. Pierre 1992; Mazza 2004). In Canada, W.D. Albright initiated the domestication of saskatoon fruit in 1918 at Agriculture Canada's Beaverlodge Research Station in Alberta by planting a hedgerow of wild saskatoon fruit; in 1952, 'Smoky' and 'Pembina' were released as the first named saskatoon cultivars (St. Pierre 1992; Davidson 1994). Other cultivars, such as 'Honeywood', 'Northline', and 'Thiessen' followed (Davidson 1994) and in the 1970's saskatoon fruit orchards began to establish in Alberta, Canada (Faye and Chaudhary 2001).

Today, saskatoon fruit continue to grow in the wild and commercially grown fruit is available to local consumers through u-pick operations and farmers' markets (Faye and Chaudhary 2001). Recent estimates indicate a 40% increase in acres planted in Alberta, Canada from 1999 to 2005; approximately 2 million pounds of fresh saskatoon fruit are produced per season in Alberta (Hausher 2006). Although in high supply over its short (4 wk) season, the marketability of fresh saskatoon fruit is currently constrained by inadequate packaging, transport, and storage systems to maintain the quality of this highly perishable crop (Williams 1994;

Rogiers and Knowles 1998, 2000). Other climacteric fruit such as apples can be harvested prior to the fully ripened state (Knee 1993), however, the large fresh weight gain that occurs in conjunction with ripening of saskatoon fruit makes it unfeasible and uneconomical to harvest the fruit before it is fully ripe (Rogiers and Knowles 1997, 1999, 2000; Rogiers and others 1998; McGarry and others 1998). As such, the majority of saskatoon fruit is sold fresh through u-pick operations or processed into value-added products such as jams, jellies, wines, syrups, and juice (Lutz 1994; Faye and Chaudhary 2001).

Recognition of health benefits of increased fresh fruit and vegetable intake including prevention of chronic diseases such as cardiovascular disease (CVD), certain types of cancer, diabetes, and obesity has set into motion global initiatives by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations to aid governments in the promotion of fruit and vegetable consumption. National programs, implemented in the early 1990's, such as "5 a Day" in North America and Europe strive to increase public awareness of the health benefits associated with daily fruit and vegetable consumption (WHO 2003). In the United States, consumption of fruit and vegetables is projected to increase by 24% to 27% between 2000 and 2020 (Lin 2004). A Canadian food statistics report indicated that while consumption of fresh fruit (kg/person) has increased by 13%, fresh vegetable consumption had declined 3% since 1993 (SC 2004).

The Canadian berry sector shows particular promise in increasing its market share as continuing research focuses on health related benefits from antioxidant activity in anthocyanin-rich berries (Oomah and Mazza 1999; AAFC 2006). The anthocyanin content of saskatoon fruit has been documented to range from 25 to 204 mg/100 g of fruit dependent on the cultivar, seasonal conditions, and maturity at harvest (Green and Mazza 1986; Mazza and Miniati 1993; Rogiers and Knowles 1997; Mazza 2004; Hu and others 2005; Zatylny and others 2005). Compared to the anthocyanin-rich blueberry, the anthocyanin content of saskatoon fruit has been described as "moderate" to "relatively equivalent" (Green and Mazza 1986; Mazza 2004).

Compositional analyses of 'Smoky' fruit compared to blueberries from a local supermarket by Mazza (1982) revealed that the saskatoon fruit maintained significantly higher amounts of protein, fat, fiber, calcium, magnesium, manganese, barium, and aluminum on a fresh weight basis.

As consumer consumption of fresh fruits increases, the demand for greater variety and higher quality commodities can also be expected to ensue (How 1993; Jaeger and others 2003a). The health promoting attributes such as anthocyanin and mineral content (Green and Mazza 1986; Mazza 1986, 2004; Hu and others 2005; Zatylny and others 2005) and the unique flavor of saskatoon fruit (benzaldehyde being a major component) (Mazza and Hodgins 1985; Lutz 1994) make the unprocessed saskatoon fruit an excellent candidate for a novel marketable small horticultural crop in and outside of Canada. Therefore, research focusing on the quality of unprocessed saskatoon fruit is needed to assess potential fresh fruit marketability.

1.2 Defining Quality of Horticultural Commodities

The definition of "quality" for horticultural commodities is dependent on the perspective of the handler. Realistically, quality is a compromise of factors which consumers, retailers, and producers assign to the product (Kader 1999). Quality from a consumers' perspective is more subjective and encompasses sensory characteristics (appearance, aroma, flavor, and texture) and factors such as nutrition, functional properties, safety concerns, convenience, and price (Abbott 1999; Kader 1999; Shewfelt 1999). Retailers, on the other hand, focus on extrinsic properties (appearance and firmness) and shelf life, while producers are interested in aspects such as high yield, desirable appearance, ease of harvest, and ability to withstand long distance transport to market (Kader 1999). When assessing quality, producers prefer instrumental measurements (such as firmness, color, sugar content, and acidity) to sensory evaluation (*i.e.* human assessment), as these measurements are tangible and are both time and cost efficient (Shewfelt 1993; Abbott 1999; Shewfelt 1999). Although producers are more interested in objective measurements to assess quality (Kader 1999; Shewfelt 1999), an objective measurement identifying a particular quality parameter in physical terms is meaningless until such a measurement is associated with a human response (Lipton 1980). Abbott (1999) and Shewfelt (1993) argue that quality is a human construct; hence, an informed knowledge of quality requires human assessment.

1.3 Sensory Evaluation

Sensory science is a discipline dedicated to evoking, measuring, analyzing, and interpreting the sensory characteristics and acceptability of food utilizing humans as instruments (Anonymous 1975). Objective techniques such as sample preparation and presentation and balanced presentation order control variation and improve the accuracy of the measurement of human response in sensory science research. Sources of experimental variation that are uncontrollable such as participant mood, motivation, and familiarity with the product can be addressed through statistical analysis of the sensory data (Lawless and Heymann 1998).

In sensory evaluation, 2 panel types exist, 1) a consumer panel to assess the preference or acceptance of a food and 2) a trained panel to identify the sensory profile of a food and to quantify the intensity of each of the attributes within the profile (Lawless and Heymann 1998; Stone and Sidel 2004a). Depending on the objective of the study, higher participation rates are required in consumer panels (n = 50 to 500) to account for variability among personal opinions/preferences of a product and selection of participants is generally based on demographic and use characteristics (Meilgaard and others 1991a; Lawless and Heymann 1998; Stone and Sidel 2004b). For trained panels, fewer participants (n = 10 to 15) are required as time is dedicated to calibrating the panel to evaluate the food as a group. Prior to participation, trained panelists are screened based on sensory acuity, availability, ability to work as part of a group, and motivation to participate (Meilgaard and others 1991b; Lawless and Heymann 1998; Stone and Sidel 2004c).

1.4 The Challenges of Sensory Evaluation of Horticultural Commodities

Sensory evaluation is a tool with a broad range of applications within the horticultural field. Examples of applications include the study of the influence of maturity at harvest, handling, and storage conditions on quality of apples (Dhanaraj and others 1980; Zerbini and others 1999), screening and selection of new apple cultivars (Deslauriers and others 1999; Hampson and others 2000), the development of preservation techniques to maintain quality of strawberries (Pelayo and others 2003; Han and others 2005), the identification of consumer segment based on individual preferences for pears (Jaeger and others 2003b), and new product development in the kiwifruit industry (Jaeger and others 2003a).

The challenges associated with sensory evaluation of horticultural commodities stem from the fact that fresh produce is amongst the most perishable of agricultural commodities and that these commodities are notoriously variable in nature (How 1993; Abbott 1999; Hampson and others 2000). While variation that exists within cultivars can be a complicating factor in sensory analysis, it argued that it is this variation that allows for a wider range of consumers to enjoy these fresh products (Shewfelt 1999; Tijskens and others 2003). Variability can exist within and between individual pieces of fruit of a single cultivar (Dever and others 1995; Abbott 1999; Jaeger and others 2003a). Both preharvest factors such as environmental conditions and cultural practices (Ferguson and others 1999; Kays 1999; Mattheis and Fellman 1999; Sams 1999) and postharvest factors such as degree of maturity at harvest and handling and storage conditions are accountable for the variable nature of these products (Salunkhe and others 1991a). Optimal ranges of postharvest storage temperatures (0 to 15 °C) and relative humidity (RH) levels (80 to 95%) selected to lower respiration and to slow metabolic and transpiration rates differ among horticultural commodities (Gast 1991; Salunkhe and others 1991b; Kader 2003).

Traditional studies comparing samples from a single batch after different durations of storage, referred to as a partially staggered design (Gacula 1975; Kilcast and Subramaniam 2000), do not accommodate simultaneous sensory evaluations of the fruit treatments (Heintz and Kader

1983). The short (4 wk) fresh saskatoon fruit season introduces a further constraint of working with a horticultural commodity; that is the limited timeframe in which to collect reliable sensory data. As with apples (Harker and others 2003), saskatoon fruit cultivars ripen at different times throughout the season largely due to environmental factors such as temperature (McGarry and others 1998). This seasonal variation in ripening dictates whether or not the assessment of each saskatoon fruit cultivar can be carried out together as the fruit needs to be of optimal eating quality when evaluated.

Although sensory evaluation is a common component of numerous horticultural publications, few sensory methodologies provide sufficient detail to be repeatable. As each horticultural product is unique, standardized protocols for handling, storage, preparation, and presentation for sensory evaluation would need to exist for groupings of horticultural products. For instance, use of a single piece of fruit for both sensory and instrumental analyses is a common method applied to apples (Harker and other 2002; Symoneaux and others 2003) as this technique is useful in controlling natural variability. However, given the average diameter of a cultivated saskatoon fruit is 1.5 cm (Harris 1972; Rogiers and Knowles 1998), this sample preparation techniques for apples is impractical for saskatoon fruit. Other preparation approaches include the puréeing of blackberries (Perkins-Veazie and Collins 2001) or the dicing of tomatoes selected from a large sample of fruits similar in shape, size, and appearance to address differences that exist within a fruit treatment (Stevens and Albright 1980). Although these preparation approaches reduce a product's natural variability, Heintz and Kader (1983) argue that a sample should be presented in its characteristic physical state.

With the knowledge that the lack of standardized protocols for sensory evaluation of horticultural commodities was leading to the misuse and misinterpretation of sensory techniques and data, Lipton (1980), Stevens and Albright (1980), and Heintz and Kader (1983) published articles in a peer-reviewed journal published by the American Society for Horticultural Science, outlining general guidelines for conducting sensory evaluation with horticultural crops. Each article addressed the need for standardized sensory evaluative procedures for horticultural commodities. The authors believed that the science of sensory evaluation needs to be as objective as possible; training, screening, and sample preparation and presentation techniques need to be well planned and consistently implemented while the testing area should facilitate the objectives and valid statistical analyses should be used to generate results.

Lipton (1980), Stevens and Albright (1980), and Heintz and Kader (1983) agreed that test facilities should create a positive work environment that will allow the panelists to function in a manner that does not undermine the experimental procedure. Lipton (1980) specified that environment influences such as, noise, privacy, lighting quality, and extraneous odors should be controlled.

Lipton (1980) noted that descriptive terminology used in the completion of both trained and consumer panels should be well defined and standardized terms (*i.e.* industry accepted) should be used when available. He also believed rating scales play a fundamental role in conveying human perception, and should reflect the type of sensory panel being used. Consumer panel rating scales should be wide enough to characterize the range of differences within a product and verbal descriptions should be associated with the main numerical anchors of a scale while trained panel rating scales should be organized to ensure product evaluations are independent of one another. Heintz and Kader (1983) encouraged dedication of time to allow the newly formed trained panel to meet and to familiarize judges with the procedures and scoring systems that will be used to evaluate the product at hand. During profile development, only the most prevalent attributes should be selected for evaluation. Line scales anchored with words to describe intensities for trained panel evaluation are more effective than the use of number/word labeled scales as they present less bias. The introduction of samples should gradually increase over time, beginning with samples that can be easily differentiated to build panel confidence.

Reference standards are an invaluable tool in aiding trained panelists in the development of terminology and anchor points for determination of different attribute intensities (Rainey

1986). Heintz and Kader (1983) noted difficulties can arise when determining suitable reference standards for horticultural products. While addition of specific quantities of sugars, acids, or chemicals into the cut tissue may yield ideal reference standards, the researcher must ensure uniform distribution of the additive into the tissue of the product. Also, as reference standards need to be consistent over the entire duration of a panel (Rainey 1986), the inherent variability of the horticultural product may alter the perceived intensity of the attribute represented by the reference standard between preparation sessions.

Sample preparation should be done within a short time frame of the evaluation in a manner that prevents the loss of volatiles and deterioration of quality (Heintz and Kader 1983). Samples should be presented at a typical temperature of consumption and instrumental analyses of the product should be carried out on the same day as the panel to minimize the effects of time on the sensory attributes of interest. The preparation of the samples for instrumental analyses should be representative of the samples evaluated by sensory panel.

Prior to evaluation, trained panelists should be reminded to read the definitions provided, palate cleanse, use references when needed, and apply sampling techniques consistently (Heintz and Kader 1983). Samples should be presented in a standardized manner (*e.g.* 3 digit codes, random presentation order and use of similar containers). Doing so will decrease bias in the evaluation as human beings by nature tend to use all information available to them to make decisions, even information that is irrelevant. During evaluation sessions, no more than 6 attributes should be assessed and no more than 8 samples should be evaluated per session to avoid fatigue.

While Stevens and Albright (1980) believed all sensory panels should be comprised of people with positive attitudes who are interested in the task at hand, Heintz and Kader (1983) found maintenance of interest and motivation in a trained panel to be a difficult task. Suggestions to maintain motivation throughout a trained panel include providing performance feedback and providing a small treat in appreciation of participation.

Ultimately, a single guideline to keep in mind when developing a protocol for sensory evaluation of any food is that the quality of the results is dictated by the quality of the methods employed to generate the results (Lipton 1980).

1.5 Sensory Evaluation of Saskatoon Fruit

Little sensory oriented work regarding saskatoon fruit has been carried out. Since the emergence of the interest in the commercial production of saskatoon fruit in the 1960's and 1970's on the Canadian prairies (St.Pierre 1992; Faye and Chaudhary 2001; Mazza 2004), only sensory evaluation of further processed products such as jelly (Mazza 1979), juice (Lutz 1994), and pie filling (Ziehl and St. Pierre 2001) has been performed.

Mazza (1979) explored expansion of the fresh market by conducting consumer acceptance home testing with saskatoon jelly ('Smoky'). Over 2 consecutive years, 600 and then 1050 57 mL jars of jelly were sold in packages also containing chokecherry and rosehip jellies and honey through retail outlets in Edmonton and Calgary, Alberta, Canada. Each package contained a questionnaire to determine motivations for purchase, use intentions, likelihood of repurchase, and general opinions and expectations of the products. The first year consumers were offered an incentive of $1 for returning the questionnaires, while the second year consumers were provided with pre-stamped envelopes in lieu of the monetary incentive. Return rates for the questionnaires were 26% and 18% each year, respectively. The native fruits products were positively received by those that responded to the questionnaire and Mazza (1979) concluded that given the low cost of production saskatoon berry producers should consider diversification into shelf-stable products such as jelly.

Lutz (1994) utilized a trained panel, consumer panels, and instrumental analyses to examine differences that existed among the sensory characteristics of saskatoon fruit ('Smoky') juices produced by 4 different commercial methods [cold pressed (3 °C), pectinase enzyme (11 °C), hemicellulose/ pectinase enzyme (20 °C), and heat pressed (77 °C)]. After 8 wks of training, the panel ($n = 6$) evaluated the juices based on appearance (color and clarity), aroma (musty/ fresh, almondy, pruney, sweet, and medicinal), and flavor (sweet, sour, dry, and strength) attributes on 15 cm unstructured line scales. Panelists evaluated each treatment 3 times in individual booths under red (aroma/ flavor) and white (appearance) fluorescent lighting. The sensory profile of the heat pressed juice was found to be unique among the juice treatments.

Lutz (1994) found that the heat pressed juice maintained a more ($p < 0.001$) intense dark cherry color and a less ($p < 0.01$) cloudy appearance than the other juice treatments. The aroma of the heat pressed juice was characterized as being more ($p < 0.001$) intense for fresh/fruity, almondy, and sweet aromas and less intense ($p < 0.001$) for pruney and medicinal aromas. Instrumental analyses (Gas Chromatography/ Mass Spectrophotometry) of volatile components of the juice indicated that the heat pressed juice had 50 times more benzaldehyde than the cold pressed juice, which supported the panel's findings that the heat pressed juice was notably more ($p < 0.001$) almondy. Although the heat pressed juice was significantly ($p < 0.001$) sweeter and less sour than the other juices, instrumental analyses of sugar and acid content did not support the panel's findings. The dry "flavor" of all the juices was perceivably the same ($p > 0.05$), while the heat processed juice maintained a stronger flavor ($p < 0.001$) than the cold juice.

To further explore the quality differences among the 4 juices, Lutz (1994) used a free choice profiling (FCP) method and 2 panels of consumers ($n = 24$/ panel). Each consumer developed his/her own descriptive terms to evaluate each of the 4 juices on 15 cm lines scales along with line scales for degree of liking. Water was provided as a palate cleanser to be used between samples. All of the descriptors developed by the trained panel were commonly recognized by the consumers; 17 common descriptors were noted among those developed individually by each consumer. Seven of the common descriptors (shiny, berry aroma, sweet aroma, sour taste, bitter taste, astringent, and strength of flavor) were used to describe each of the juices while the remaining 10 descriptors (cherry/ wine/ red, brown, sedimenty/ cloudy, fruity/

almondy/ medicinal/ pruney/ musty/ fresh aroma, and sweet flavor) were used to differentiate among the juices.

The profiles of Lutz's (1994) trained and consumer panels were analyzed separately using Generalized Procrustes Analysis (GPA). Three 2-dimensional consensus plots indicated that 95%, 82%, and 84% of the variation in the trained panel and the 2 consumer panels' models were explained by the first 2 dimensions, respectively. By superimposing the 3 consensus plots over each another it could be seen that the trained and consumer panels' descriptions of the juices were similar. The trained panel perceived greater differences among the juices based on sour taste and sweet aroma attributes than the consumer panels. A consensus plot constructed using the 10 FCP descriptors that were used to differentiate among the juices, classified the heat pressed juice as wine red, clear, sweet flavor, fresh/ fruity, and almondy while the other juices were described as brownish, sedimenty, musty/ earthy, and pruney. The heat pressed juice was liked more ($p < 0.001$) by the consumers than the other juices.

To further aid in the promotion of value-added saskatoon fruit products, Ziehl and St. Pierre (2001) employed a multiple comparison method to evaluate pie fillings made from 14 different frozen saskatoon fruit cultivars ('Bluff', 'Buffalo', 'Honeywood', 'Martin', 'Nelson', 'Northline', 'Par90TRS', 'Pasture', 'Pembina', 'Quaker', 'Regent', 'Smoky' , 'Success', and 'Thiessen') based on tartness, sweetness, firmness, seediness, flavor intensity, and flavor acceptability. The 'Thiessen' fruit pie filling was used as a reference. The pie filling of each cultivar was evaluated 6 times using a completely randomized block design. Sixteen of 24 panelists screened for their abilities to differentiate among samples with increased and decreased concentrations of sugars, malic acid, and added flavors (*i.e.* almond extract, lemon oil, tea flavor, and oak flavor) completed the study. During evaluations, the reference standard (50 g) labeled "R" was presented along with the pie filling samples (30 g) under blue lighting in individual sensory booths. The samples (30 g) of the pie fillings were randomly assigned 3 digit codes and orders of presentation. An ANOVA was carried out on each of the attributes and means were separated using Tukey's tests ($p < 0.05$). The study revealed that pie fillings made from 'Nelson' and 'Northline' maintained significantly ($p < 0.05$) lower flavor acceptability ratings than the pie filling made from 'Thiessen' while the flavor acceptability ratings of the remaining 11 cultivars were not distinguishable from 'Thiessen'.

The sensory work conducted by Mazza (1979), Lutz (1994), and Ziehl and St. Pierre (2001) provided valuable insight into the sensory characteristics of common value-added products processed from saskatoon fruit. With increased public awareness of the health benefits associated with fresh fruit consumption (Southon and Faulks 2002), sensory evaluation of freshly harvested saskatoon fruit, not previously performed, will play a fundamental role in assessing the quality and potential marketability of this fresh fruit.

1.6 Research Objectives

The overall purpose of this research was to use sensory evaluation in conjunction with instrumental analyses as tools to explore the quality changes that occur in fresh saskatoon fruit over a potential storage period and temperature (5 d at 4 °C) that may be applied to fresh saskatoon fruit by retailers and consumers.

The objectives of this research were as follows:

1) to develop aroma, texture, and flavor profiles of fruit from 3 common commercially available cultivars ('Thiessen', 'Northline', and 'Smoky') of fresh (unprocessed) saskatoon fruit over 3 consecutive seasons and to then use the profiles to monitor sensory changes in the fruit that occur over storage at 4 °C for 5 d (short-term refrigeration temperature).

2) to gain knowledge of local consumer acceptance of fruit from these common commercially produced cultivars over a short-term storage regime (5 d at 4 °C), to explore the quality changes of the fruit from each cultivar over storage, and to identify the most preferred fruit cultivar for local fresh fruit marketing.

3) to gain preliminary knowledge of consumer perceptions of saskatoon fruit and appropriate positioning and pricing of this fresh product in the domestic market.

The first objective is addressed in Chapter 2 while the second and third objectives are addressed in Chapter 3.

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2. Saskatoon Fruit (*Amelanchier alnifolia* Nutt.) Quality Over Five Days of Storage at 4 °C Part I: Descriptive Profiles and Instrumental Evaluations

2.1 Introduction

The saskatoon fruit (*Amelanchier alnifolia* Nutt.) is a small fruit crop native to North America with a longstanding history of consumption among native Americans and settlers alike (Harris 1972; Mazza 1986; St. Pierre 1992). Recent estimates indicate planted acres in Alberta increased by 40% from 1999 to 2005 (Hausher 2006). As a result, the supply of saskatoon fruit is high over its short fresh season (4 wk). Unlike other climacteric fruit, such as apples that can be harvested at physiological maturity (Knee 1993), the large fresh weight gain that occurs in conjunction with ripening of saskatoon fruit makes it unfeasible and uneconomical to harvest the fruit before it is fully ripe (Rogiers and Knowles 1997, 1999, 2000; Rogiers and others 1998; McGarry and others 1998). To date, the marketability of fresh saskatoon fruit is constrained by inadequate packaging, transport, and storage systems to maintain the quality of this highly perishable crop (Williams 1994; Rogiers and Knowles 1998, 2000). As such, the majority of this fruit is sold for further processing into value-added products (Lutz 1994; Faye and Chaudhary 2001).

Like all horticultural commodities, the saskatoon fruit possesses inherit characteristics that make the establishment of a reliable sensory profile a challenge (Heintz and Kader 1983; Jaeger and others 2003). Given biological variation that can exist among individual pieces of fruit from the same cultivar (Dever and others 1995; Abbott 1999) and seasonal variability due to preharvest environmental conditions and cultural practices (Ferguson and others 1999; Kays 1999; Mattheis and Fellman 1999; Sams 1999), consistent sensory evaluative techniques are key to characterizing the sensory profile of a horticultural commodity (Lipton 1980; Stevens and Albright 1980; Heintz and Kader 1983).

Although sensory evaluation of jelly (Mazza 1979), processed juice (Lutz 1994), and pie filling (Ziehl and St. Pierre 2001) has been conducted, the sensory profile of fresh saskatoon fruit has never been examined. The development of descriptive profiles of fresh saskatoon fruit will be an invaluable tool to benchmark the fresh quality of fruit treated with future packaging and preservation technologies.

The objectives of this study were to develop aroma, texture, and flavor profiles of freshly harvested saskatoon fruit from 3 commercially available cultivars ('Thiessen', 'Northline', and 'Smoky') over 3 consecutive seasons and to then use the profiles to monitor sensory changes in the fruit that occur over storage at 4 °C for 5 d.

2.2 Materials and Methods

2.2.1 Fruit Source, Storage Conditions, and Sample Preparation

Mature-ripe saskatoon fruit (*Amelanchier alnifolia* Nutt.) from 3 cultivars ('Thiessen', 'Northline', and 'Smoky') were obtained from a local grower (Spruce Grove, AB., Canada) over 3 consecutive seasons (2003, 2004, and 2005). The fruit (2.25 kg per cultivar/treatment) were hand-harvested, cleaned to remove debris and damaged fruit, and held at refrigeration temperature in 4 L plastic pails with lids for up to 12 h prior to transportation, at ambient temperature, from the farm to the sensory facility. In 2005, the fruit were spread on toweled trays to remove condensation that had built up during transportation. The fruit were then returned to the containers and the covered fruit were held at 4 °C.

Once at the sensory facility the fruit were held at room temperature (21 °C) overnight prior to evaluation (2003), or stored at 4 °C and placed at room temperature 3 h prior to evaluation (2004). In both cases, these fruit were designated as "unstored fruit" and were evaluated within 28 h of harvest. In 2003 and 2004, the fruit were placed in deionized water for a maximum of 30 min, damaged and unripened fruit (red colored) and debris were removed, and 40 g of fruit from each cultivar were packaged in 120 mL styrofoam cups with lids.

In 2005, fruit from each cultivar were harvested both 3 d and 5 d in advance and stored for comparison to unstored fruit during a single sitting. The design of the study with the trained panel mimicked the storage regime for a consumer panel that evaluated a different set of fruit over 5 d of storage at 4 °C from the same harvest year (Chapter 3). Similar to 2003 and 2004, unstored fruit from each cultivar in 2005 were evaluated within 28 h of harvest. The stored fruit from each cultivar were placed at room temperature 15 h prior to evaluation. Both the stored fruit and unstored fruit from each cultivar were spread out on towels 1 h prior to evaluation. Damaged and unripened fruit (red colored) were removed and fruit of uniform shape, size, and color (purple) were selected for evaluation. Forty grams of each cultivar/storage treatment were packaged in 120 mL styrofoam cups with lids.

2.2.2 Sensory Evaluation

The aroma, texture, and flavor profiles of fruit from the 3 saskatoon cultivars were developed and refined over the course of 3 consecutive seasons (2003, 2004, and 2005).

2.2.2.1 Panelist Recruitment

Prior to commencement of the trained panels, protocols for recruiting and sample evaluations were approved by the Research Ethics Board, Faculty of Agriculture, Forestry and Home Economics at the University of Alberta, Edmonton, AB, Canada (See Appendices, Section 5.1.1).

Each trained panel was selected from students and staff of the University of Alberta. Recruitment and screening procedures were carried over from season to season (Meilgaard and others 1991a). Modifications were made to the 2005 screening procedure to include an odor identification test and a descriptor generation exercise using saskatoon fruit juice obtained from a local producer (Leduc, AB., Canada). Sensory attributes developed and quantified by Lutz (1994) for heat pressed saskatoon fruit juice aided in panelist selection.

2.2.2.2 Profile Development and Reference Standard Preparation

Given the short duration of the fresh saskatoon fruit season (4 wk), the primary objective of the 2003 trained panel (5 males and 6 females) was to develop and finalize the aroma, texture, and flavor descriptors of the fresh fruit from the 3 cultivars through descriptive analysis (DA) (Meilgaard and others 1991b; Lawless and Heymann 1998). During this time reference standards (R2) were optimized and anchored on the 15 cm unstructured line scales.

The objective of the 2004 trained panel (3 males and 8 females) was to utilize the existing profiles to evaluate the fresh fruit from the same 3 cultivars. In 2004, all reference standards (R2) remained constant in concentration and form of delivery (solution based) from the preceding trained panel (2003). In the 2005 season (2 males and 10 females) the objective was to evaluate the aroma, texture, and flavor profiles of the fruit from the same 3 fruit cultivars over 5 d of storage at 4 °C. During this time additional reference standards (R1) were added to the existing line scales to aid in the quantification of lower intensity attributes.

Reference standards (Table 2.1) were prepared from food grade chemicals with the exception of the initial juiciness, firmness and seed size references. During the evaluation sessions, all reference standards were made available to the panel and were served at room temperature with the exception of the firmness standard. The earthy reference standards were prepared in 250 mL plastic squeeze bottles with forced air caps for the retronasal perception. The firmness and earthy reference standards (Table 2.1) were developed and utilized in 2005 only.

2.2.2.3 Training Sessions

Each trained panel completed 10- 1 hr training sessions prior to evaluations of the fruit from the 3 cultivars. Attribute definitions and sampling techniques for the reference standards and fruit samples are presented in Tables 2.2 and 2.3. Sampling techniques for the reference standards and fruit samples were implemented to ensure uniform evaluations. To further ensure the consistency of each panelist's intensity perceptions and to average fruit variability, 2005 panelists were instructed to perform at least 2 overall evaluations for the aroma, texture, and flavor attributes before finalizing their placements of the evaluation of the fruit on the scales.

Prior to fruit evaluations each season, 2 mock evaluation sessions were conducted under true evaluation conditions to assess individual panelist reliability and problem areas were addressed prior to true evaluation sessions. Using Compusense Five® (Version 3.6., Compusense Inc., Guelph, ON., Canada) each attribute was evaluated on unstructured 15 cm intensity line scales with the exception of seed presence and size attributes which were rated as 'high' to 'low' and 'large' to 'small', respectively. All intensity scales were anchored with "not very at all" on the left to "very" on the right. In 2004, paper ballots were used in place of Compusense®.

2.2.2.4 Sample Evaluations

Three replications of trained panel evaluations of the fruit from each cultivar were conducted each season. In 2005, due to staggered seasonal ripening of the different cultivars, panelists evaluated the stored and unstored fruit from 'Thiessen' (n = 3) prior to the stored and unstored fruit from 'Northline' and 'Smoky' (n = 6).

During each evaluation session, panelists were presented with the fruit samples in sensory booths under incandescent lighting. Presentation orders of the samples were balanced and randomly assigned to panelists using Compusense Five®. Room temperature distilled water and water crackers (Western Family, Vancouver, BC, Canada) were provided as palate cleansers and panelists were instructed to cleanse the palate between reference standards/samples to minimize fatigue. In 2003 and 2004, unsalted saltine crackers (Sunfresh Ltd., ON, Canada) were used as palate cleansers. Expectoration cups were provided for reference standards.

2.2.3 Instrumental Analyses

Each season, instrumental analyses were conducted in conjunction with sensory evaluations. Fruit were evaluated for firmness, color, and percent moisture (3 replicates per treatment). In 2005, the fruit were subjected to the same instrumental analyses prior to and after storage (pre-stored and stored fruit, respectively) at 4 °C for both 3 d and 5 d.

Fruit firmness measurements were performed using a 50 Kg load Kramer Shear Compression Cell (Instron Corp., Canton, MA, USA) attached to an Instron Universal Testing System (Instron Corp.). Thirty grams of fruit were evenly distributed to form 1 layer within the cell and measurements were expressed as kilograms per gram of fruit (Kg/g). The down speed of the crosshead was 100 mm/min.

For color measurements, in 2004, 40 g of fruit were crushed with a mortar and pestle, filtered through 6 layers of Purewipe® grade 40 cheesecloth (American Fiber & Finishing, Inc., Albemarle, NC., U.S.A.), and 6 g of the filtrate were weighed into a 60 mm x 15 mm petri dish. In 2005, a modified method developed by McGarry and others (2005) to measure surface color of whole fruit was used; 10 g of fruit were placed in 60 mm x 15 mm petri dishes. In both cases, a HunterLab Labscan® XE (Model LSXE/Uni, Hunter Associates Laboratory Inc., Reston, Va., U.S.A.) calibrated with standardized black and white tiles was used to take color measurements through a half inch diameter port (L, a, and b measured with 3- 120° rotations of the petri dish). Chroma (C; color saturation or intensity) and hue angle (h°; the basic tint of color) values were calculated from a and b values as described by McGuire (1992). Five grams of each treatment were held at 60 °C for 4 d in a forced air oven (Model 104, Fisher Scientific Inc., Pittsburgh, Pa., U.S.A.) to quantify percent moisture (Wrolstad and others 2005).

The fruit evaluated by the 2004 and 2005 panels were frozen (-25 °C) the day of evaluation for soluble solids content (SSC) and titratable acidity (TA) analyses at a later date. Samples of the 2005 fruit prior to storage at 4 °C for both 3 d and 5 d were frozen (-25 °C) the day of procurement for SSC and TA analyses. Soluble solids content was determined using a modified juice extraction method developed by Rogiers and Knowles (1997). Thawed fruit (3 g in 2004; 20 g in 2005) were crushed with a mortar and pestle and filtered through 6 layers of Purewipe® grade 40 cheesecloth. The filtrate was centrifuged at 1640 x *g* for 15 min. The refractive index and °Brix values were determined from the supernant (AOAC 2000a) with a Zeiss Abbe refractometer (Carl Zeiss Oberkochen, Wurtt, Germany), which was calibrated with 0% and 10% sucrose solutions.

Using the preparation technique of McGarry and others (2005), TA and initial pH were analyzed by glass electrode method (AOAC 2000b) using an Accumet basic pH meter (Model AB15, Fisher Scientific Inc., Pittsburgh, Pa., U.S.A.). The average of 2 determinations per sample was used to calculate the SSC and TA values. Soluble solids content was expressed as °Brix and TA as percent malic acid equivalents (% malic acid eq.).

2.2.4 Statistical Analyses

The 2003 sensory data was not statistically analyzed. The sensory and instrumental data collected in 2004 and 2005 were analyzed by an analysis of variance (ANOVA) using SAS® version 9.1 (SAS Institute Inc., Cary, NC, USA). As the handling of the fruit between the 2004 and 2005 seasons differed, the sensory and instrumental data were statistical analyzed within each year only. Within the sensory data, outliers were defined as those that deviated more than 1.5 times the standard deviation from the mean (Wilcox 2001). Outliers were eliminated on an individual attribute basis. PROC MIXED (SAS) was used to analyze the sensory and instrumental data and least square mean separations were based on Tukey's adjustments ($p \leq 0.05$). The main effects within the sensory data, cultivar and judge, were fixed, while session (3 per cultivar/storage treatment) was a random effect. In 2005, treatment [stored (3 d and 5 d) and unstored fruit evaluated by the panel] was included as a fixed effect. Within each sensory attribute, all 2 way interactions were tested for significance ($p \leq 0.05$) for 2004 and 2005. Within the instrumental data, cultivar was a fixed effect, while session (3 per cultivar/storage treatment) was a random effect. In 2005, treatment [pre-stored (3 d and 5 d) fruit and stored (3 d and 5 d) and unstored fruit evaluated by the panel] was included as a fixed effect.

2.3 Results and Discussion

The development of the saskatoon fruit descriptive profiles over the consecutive seasons was necessary to produce reliable sensory profiles as seasonal variability of saskatoon fruit quality parameters can be high (McGarry and others 2005).

2.3.1 Freshly Harvested (Unstored) Fruit Sensory Profiles: Season to Season

The 2004 and 2005 descriptive profiles of fruit within each of the 3 saskatoon cultivars were similar (Table 2.4). Although the 2004 and 2005 panels utilized the unstructured line scales differently, the relative intensity ratings among the unstored fruit from the 3 cultivars were similar from season to season. Differences in the intensity perceptions between the panels can largely be attributed to the refinement of reference standards (such as the earthy flavor standard), the focus on uniform sampling techniques of both the reference standards and fruit samples, and the introduction of R1 to the unstructured line scales in 2005 which aided panelist differentiation among the fresh fruit from the 3 cultivars and reduced outliers (Table 2.3). Enforcement of attribute definitions (Table 2.2) and uniform sample/reference standard preparation and treatment storage/evaluation conditions played an important role in controlling variability in the evaluation sessions.

For 2004 and 2005, the cultivar × judge interactions were not significant ($p > 0.05$) with the exception of earthy flavor in 2004 and grassy aroma and flavor, musty aroma, and astringency in 2005. Regardless of the significant ($p \leq 0.05$) cultivar × judge interactions, notable trends that existed between the 2004 and 2005 aroma, texture, and flavor profiles and the instrumental analyses are discussed.

In both seasons, the trained panels did not perceive differences ($p > 0.05$) in the intensities of the musty aroma and overall saskatoon flavor intensity (OSFI) among the unstored fruit from the 3 cultivars (Table 2.4). With the addition of R1 in 2005, the panel noted differences ($p \leq 0.05$) in the grassy aroma intensities among the unstored fruit from the 3 cultivars; 'Thiessen' was more ($p \leq 0.05$) intense than 'Northline' and 'Smoky'. Both panels found the fresh/fruity aroma more ($p \leq 0.05$) prevalent in the unstored fruit from 'Thiessen' than those of 'Northline'.

Similar trends in intensity ratings of the unstored fruit's textural attributes were observed among the cultivars in both years. Both panels perceived significant ($p \leq 0.05$) differences among the firmness intensities of the unstored fruit from each cultivar, where 'Northline' was significantly ($p \leq 0.05$) firmer than the other cultivars (Table 2.4). Only the 2005 trained panel perceived a difference ($p \leq 0.05$) among the initial juiciness intensities of the unstored fruit from the 3 cultivars; 'Thiessen' and 'Smoky' maintained significantly ($p \leq 0.05$) greater intensities of initial juiciness than 'Northline', which was contrary to the panel's firmness intensity ratings among the unstored fruit from the 3 cultivars. The instrumental firmness and percent moisture measurements did not parallel the panels' findings (Tables 2.5 and 2.6). Harker and others (1997) demonstrate the difficulty of finding instrumental measurements that can fully capture the sensitivity of human perception to textural attributes in fruit and vegetables of varying intensities of hardness and juiciness. Based on psychophysical theory, human perception of textural change tends to be non-linear while instrumental measures tend to follow linear trends (Rosenthal 1999). As such, the training of humans to act as a reliable instrument to accurately measure textural attributes in foods is necessary in the assessment of quality (Bourne 1980; Rosenthal 1999). Among the unstored fruit from the 3 cultivars evaluated by the 2004 and 2005 panels, a single cultivar was not perceived ($p > 0.05$) to be more astringent than another (Table 2.4).

A single cultivar was not identified as possessing a particular size of a single seed (seed size) (data not shown). In 2004, the majority of the panelists evaluated the size of a single seed to be comparable to the sesame seed reference (medium) while the majority of the 2005 panelists rated the fruit seeds as 'large' (data not shown). In both years, the unstored fruit from 'Thiessen' was more frequently chosen as the cultivar that possessed a 'low' seed presence while the seed presence ratings for the unstored fruit from 'Northline' and 'Smoky' were divided between 'low' and 'medium' (data not shown). While McGarry and others (1998) reported that fruit from

'Thiessen' possessed significantly ($p < 0.01$) higher numbers of seeds per fruit compared to fruit from 'Northline' and 'Smoky', they also reported that fruit from 'Thiessen' were larger than fruit from 'Northline' and 'Smoky' based on fruit fresh and dry weight and total fruit area (McGarry and others 1998, 2001). As seed presence was defined as "the presence of seeds in a single fruit relative to the entire fruit volume", the sensory data from the trained panels suggests that the degree of seed presence in a small fruit is perceived in context to the volume of the entire fruit.

Both trained panels perceived the unstored fruit from 'Smoky' to be less ($p \leq 0.05$) sour and more ($p \leq 0.05$) sweet than the unstored fruit from 'Northline' (Table 2.4). The 2004 and 2005 instrumental analyses of initial pH, TA, and the SSC/TA ratios of the unstored fruit from each cultivar supported the panels' findings (Tables 2.5 and 2.6). In both seasons, the initial pH values were significantly ($p \leq 0.05$) higher in the unstored fruit from 'Smoky' than in the unstored fruit from 'Northline'. While the TA values were significantly ($p \leq 0.05$) lower in the unstored fruit from 'Smoky' than in the unstored fruit from 'Northline', the SSC/TA ratios were significantly ($p \leq 0.05$) greater in the unstored fruit from 'Smoky' than in the unstored fruit from 'Northline'. In 2004 and 2005, the unstored fruit from 'Smoky' maintained the lowest ($p \leq 0.05$) intensity of grassy flavor among the cultivars (Table 2.4). In 2005, the unstored fruit from 'Thiessen' received a greater ($p \leq 0.05$) earthy intensity rating than the unstored fruit from 'Smoky'.

No significant differences ($p > 0.05$) existed among the lightness (L), chroma (C), and hue (h^o) values of the unstored fruit from the 3 cultivars in 2004 (Table 2.5). Although differences ($p \leq 0.05$) were observed among the instrumental color measurements (L, C, and h^o values) of the 2005 unstored fruit from the 3 cultivars, no practical color differences were notable (Table 2.6).

2.3.2 The Effects of 5 Days of Storage at 4 °C on Sensory Profiles

The sensory attributes of fruit from each cultivar were evaluated over 5 d of storage at 4 °C [Tables 2.7a, attributes with non significant ($p > 0.05$) cultivar × treatment interactions; and 2.7b, attributes with significant ($p \leq 0.05$) cultivar × treatment interactions].

The characteristic aroma attributes of fresh/fruity, grassy, and musty, within each of the saskatoon fruit cultivars, did not change ($p > 0.05$) in intensity as a result of 5 d of storage (Tables 2.7a and 2.7b). Regardless of storage duration, the grassy aroma of 'Thiessen' was perceivably ($p \leq 0.05$) more intense than the other cultivars, while 'Thiessen' and 'Smoky' had more ($p \leq 0.05$) intense fresh/fruity notes than 'Northline' (Table 2.7a).

As texture is a functional part of flavor release (Delwiche 2004; Harker and others 2006) and plays its own role in maintaining quality of a product, the changes that occurred in the fruit over storage are equally as important as the changes in flavor (Szczesniak and Kahn 1971; Bourne 1980). Within each cultivar, initial juiciness intensity ratings significantly ($p \leq 0.05$) increased as a result of both 3 d and 5 d of storage compared to the unstored fruit (Table 2.7a). Regardless of storage duration, 'Thiessen' maintained a significantly ($p \leq 0.05$) higher intensity of initial juiciness than 'Northline' and 'Smoky'. While the panel's ratings of firmness intensities of 'Northline' and 'Smoky' were unchanged ($p > 0.05$) after 5 d of storage, fruit stored for 5 d from 'Thiessen' were perceived to be significantly ($p \leq 0.05$) firmer than unstored fruit and fruit stored for 3 d. Among the stored and unstored fruit from 'Northline' and 'Smoky' evaluated by the panel, fruit from 'Northline' were significantly ($p \leq 0.05$) firmer than the analogous fruit treatments from 'Smoky' (Table 2.7b). As with the unstored fruit from each cultivar, the trained panel's textural ratings for initial juiciness and firmness of the fruit over 5 d of storage (Tables 2.7a and 2.7b) were not always supported by the corresponding instrumental analyses (Tables 2.6 and 2.8). Changes ($p \leq 0.05$) in the intensity ratings of astringency of the fruit over the 5 d of storage at 4 °C differed among the cultivars (Table 2.7b). Fruit from 'Thiessen' stored for 5 d were significantly ($p \leq 0.05$) more astringent than the unstored fruit. Also, fruit stored for 5 d from 'Thiessen' were more ($p \leq 0.05$) astringent than the other cultivars stored for the same duration.

Trained panel assessment of the changes in the key attributes of saskatoon fruit flavor indicated that duration of storage did not influence ($p > 0.05$) the perceivable intensities of the grassy flavor, earthy, and OSFI attributes of the fruit from each cultivar (Table 2.7a). Regardless of storage, 'Thiessen' maintained significantly ($p \leq 0.05$) higher intensities of grassy and earthy flavors, whereas 'Northline' possessed a greater ($p \leq 0.05$) OSFI than 'Thiessen'. Based on perceivable sour intensities in the fruit, however, 'Northline' was influenced differently by the 5 d of storage at 4 °C compared to 'Thiessen' and 'Smoky'. Within 'Thiessen' and 'Smoky', the trained panel did not identify significant ($p > 0.05$) differences in the intensities of the sweet and sour tastes of the stored and unstored fruit. While the sweet tastes among the stored and unstored fruit from 'Northline' were not perceivably ($p > 0.05$) different, the sour taste was perceivably ($p \leq 0.05$) lower in the fruit stored for 5 d than in the unstored fruit. Within each cultivar, the SSC/TA ratios of the stored and unstored fruit supported both the panel's perceptions of sweet and sour tastes (Table 2.8). No significant ($p \leq 0.05$) different existed among the SSC/TA ratios of the stored and unstored fruit within 'Thiessen' and 'Smoky', while the SSC/TA ratio of the fruit stored for 5 d from 'Northline' was higher ($p \leq 0.05$) than the unstored fruit. With the exception of 'Thiessen', the initial pH values of the fruit within each cultivar stored for 5 d evaluated by the panel were higher ($p \leq 0.05$) than the values of the unstored counterparts. Although the TA values of the fruit within each cultivar stored for 5 d evaluated by the panel were significantly ($p \leq 0.05$) lower than the unstored fruit, it is apparent the only perceivable ($p \leq 0.05$) decline in TA after 5 d of storage could be detected by the trained panel in 'Northline' (Table 2.7b and 2.8).

Regardless of storage duration, the panel intensity ratings indicated that the fruit from 'Thiessen' and 'Smoky' were perceivably ($p \leq 0.05$) less sour than the fruit from 'Northline' (Table 2.7b). However, initial pH, and TA values indicated that fruit from 'Thiessen' and

'Northline' evaluated by the panel maintained similar "sour" profiles compared to fruit from 'Smoky' (Table 2.6). Additionally, the SSC values and the SSC/TA ratios were significantly ($p \leq 0.05$) lower in the stored and unstored fruit from 'Thiessen' evaluated by the panel compared to the analogous treatments from 'Smoky', however, the panel could not perceive differences ($p > 0.05$) between the sweet intensities of the fruit evaluated from 'Thiessen' and 'Smoky' (Tables 2.6 and 2.7b). As flavor perception is influenced by both volatile and non-volatile components (Pangborn 1960), the interaction of tastes and odors can alter human perception of the intensity of each component (Delwiche 2004). As such, it can be hypothesized that the more intense aroma profile of fruit from 'Thiessen', compared to the other cultivars, may partially account for why the non-volatile related instrumental measurements did not support the trained panel's findings that the sweet and sour taste intensities of fruit from 'Thiessen' were more similar to fruit from 'Smoky' compared to fruit from 'Northline'.

Similar to the unstored fruit from each cultivar, no trends in L, C, and h° values were noted among and within the fruit from each cultivar over storage (Tables 2.6 and 2.8). Regardless of storage duration, all of the cultivars could be described as being bluish-purple (270° to 360°) in surface color.

The experimental design implemented in this study was chosen to allow participants in the saskatoon fruit consumer panel study (Chapter 3) to evaluate all the storage treatments (fruit stored for both 3 d and 5 d and unstored fruit) of different sets of fruit in a single sitting. With the exception of fruit from 'Smoky', examination of the influence of both 3 d and 5 d of storage on the SSC/TA ratios of each cultivar indicated that the trained panel experienced similar sweet and sour taste changes as they would have if the fruit had been from a single batch and portions removed from storage for periodic evaluation (Tables 2.7b and 2.8). The percent moisture and instrumental firmness values of the fruit from each cultivar prior to and after storage for both 3 d and 5 d did not tend to parallel the panel's initial juiciness and firmness intensities ratings over storage (Tables 2.7a, 2.7b, and 2.8).

2.4 Conclusion

The examination of the influence of short-term storage (5 d at 4 °C) on the sensory profiles of each of the saskatoon fruit cultivars demonstrates the usefulness of the aroma, texture, and flavor profiles developed in this study. The degree of change within the sensory profiles of fruit stored at 4 °C for 5 d was different for each cultivar. While fresh/fruity aroma, musty aroma, grassy aroma and flavor, earthy flavor, sweet taste, and overall saskatoon flavor intensity (OSFI) intensities of the fruit within each of the cultivars did not significantly ($p > 0.05$) change as a result of 5 d of storage, the initial juiciness of fruit from each cultivar stored for both 3 d and 5 d significantly ($p \leq 0.05$) increased compared to the unstored fruit. After 5 d of storage, only the firmness and astringency intensities of 'Thiessen' significantly ($p \leq 0.05$) increased. While the TA values of fruit from each cultivar consistently ($p \leq 0.05$) declined after 5 d of storage, the change in sour intensity was only perceivable in 'Northline' after the 5 d of storage by the trained panel. Although the OSFI did not differ ($p > 0.05$) among the unstored fruit from the 3 cultivars, the fruit from 'Northline' possessed a significantly ($p \leq 0.05$) higher OSFI than the fruit from 'Thiessen' over the course of 5 d storage at 4 °C.

The refinement of the sensory profiles of the fruit from the 3 freshly harvested saskatoon fruit cultivars over the 3 short consecutive seasons was necessary to fully develop the aroma, texture, and flavor profiles of the cultivars. The resulting descriptive profiles are an invaluable tool that can be useful in evaluating the quality of this fruit for current and future marketability.

Table 2.1: Aroma, texture, and flavor attribute reference standards with corresponding solution concentrations and placement on the 15 cm unstructured line scales for the trained panel evaluation of saskatoon fruit

Attribute	Reference Standard	Reference Concentration	Line Scale Placement	Reference Concentration	Line Scale Placement
Aroma					
Fresh/Fruity	Apple flavor (Hilltech Canada Inc., Vankleek, ON, Canada)	0.5mL/L	4.0 cm	4.5mL/L	9.0 cm
Musty	Saskatoon flavor (Aromatic & Flavours Inc., Scarborough, ON, Canada)	0.188mL/l	4.0 cm	3.75mL/L	9.5 cm
Grassy	Cis-3-hexen-1-ol (Aldrich Chemical Company, Inc., Milwaukee, WI, USA)	20µL/L	4.0 cm	40µL/L	9.0 cm
Texture					
Firmness[x]	Knox Gelatine (Associated Brands Inc.)	29.2g/L	4.0 cm	52.7g/L	10.0 cm
Initial Juiciness[y]	Bamboo Shoots (Bangkok, Thailand)	-	-	2.5cm slice	10.0 cm
Astringency	Clubhouse Alum (McCormick Canada, London, ON, Canada)	Welch's Grape Juice	6.5 cm	0.7g/L	9.5 cm
Seed Presence	-	-	-	-	-
Seed Size	Sesame Seed (Sunfresh Limited, Toronto, ON, Canada)	-	-	-	medium
Flavor					
Sweet	Sucrose (Fisher Scientific Co., Fair Lawn, NJ, USA)	30g/L	5.0 cm	50g/L	9.5 cm
Sour	Citric Acid (Fisher Scientific Co., Fair Lawn, NJ, USA)	0.48g/L	5.0 cm	1g/L	10.5 cm
Grassy	Cis-3-hexen-1-ol (Aldrich Chemical Company, Inc., Milwaukee, WI, USA)	7.5µL/L	4.0 cm	40µL/L	9.0 cm
Earthy	Earthy flavor (Hilltech Canada Inc., Vankleek, ON, Canada)	7.5µL/50g canola oil	2.0 cm	22.5µL/50g canola oil	6.0 cm
Overall Saskatoon Flavor Intensity (OSFI)	Saskatoon flavor (Aromatic & Flavours Inc., Scarborough, ON, Canada)	30 µL/L	4.0 cm	100µL/L	9.5 cm

[x] the gelatine cubes (1.5 cm^3) were removed from 4 °C 15 min before evaluations commenced to ensure uniform firmness

[y] bamboo shoots were removed from their room temperature brine 10 min prior to evaluations to ensure uniform 'initial juiciness' for the trained panelists

Table 2.2: Aroma, texture, and flavor attributes with definitions for use by the trained panel

Attribute	Definition
Aroma	
Fresh/Fruity	Aroma associated with a mixture of non-specific fruits: fruit, apples/pears, tropical, melons and citrus fruits; not overpowering/light perfume-like fragrance
Musty	Aroma associated with closed air spaces such as attics and closets (dry) and basements (wet)/old, moldy and heavy aroma (damp)
Grassy	Aroma associated with fermented fruits, vegetables (can be yeasty) or grains/green, slightly sweet/sharp aromatic associated with cut grass/ leafy
Texture	
Firmness	The force required to compress 3 uniform sized fruit by pressing with the tongue against the roof of the mouth
Initial Juiciness	The level of juice produced after the first 2 bites of the fruit between the molar teeth
Astringency	The sensation on the tongue or other skin surfaces of the oral cavity described as puckering/dry and associated with tannins or alum
Seed Presence	The presence of seeds in a single fruit relative to the entire fruit volume
Seed Size	The average size of seeds present in a single fruit
Flavor	
Sweet	Basic taste on the tongue stimulated by sugars and high potency sweeteners
Sour	Basic taste on tongue stimulated by acids
Grassy	Green, slightly sweet/sharp aromatic associated with cut grass/leafy /aromatic associated with fermented fruits, vegetables (can be yeasty) or grains
Earthy	Aromatic flavor associated characteristic of damp soil (moldy), wet foliage, slightly undercooked boiled potato or the casing of Brie cheese
Overall Saskatoon Flavor Intensity (OSFI)	The ideal flavor tasted from a saskatoon fruit/sweet, slightly tart, nutty, mild to moderate flavor (not overpowering)

Table 2.3: Techniques for the trained panel evaluation of saskatoon fruit reference standards and fruit samples

Sensory Standard & Sample	Sampling Technique
Aroma	
Fresh/Fruity, Grassy & Musty Standards	Holding close to the nose, lift the lid off the sample cup and inhale deeply through the nose. Exhale out the nose ONLY. Replace the lid and repeat if necessary after rest for 1 min (shake the sample vigorously for 30 sec before re-sampling).
Fruit Samples	Panelists were to simultaneously gently shake their cups of fruit before placing the covered container to their nose and while lifting the lid they inhaled deeply to evaluate the aroma characteristics. For aroma attribute evaluations, panelists were instructed to exhale out of their nose only.
Texture	
Initial Juiciness Standard	Remove the saliva in the mouth before placing a bamboo shoot between you molar teeth. Hold the shoot in place with the side of the tongue. Bite twice into the bamboo shoot and focus on the juice/water that is release into the mouth.
Firmness Standards	Place the cube (1.5 cm^3) of gelatin on your tongue and press the cube to the roof of your mouth. Focus on the force required to compress (break through) the entire gelatin cube.
Astringency Standards	Swish the standards around the mouth for 5 sec. Swallow the standard and focus on the drying sensation in the mouth.
Seed Size Standard	Place a sesame seed in the mouth and focus on familiarizing yourself with how its size feels using your tongue.
Fruit Samples	Panelists removed the saliva from their mouths and evaluated single fruit of uniform shape, size and color for initial juiciness, seed presence, and seed size. Each fruit was placed between the molars and compressed twice before the amount of juice present in the mouth was evaluated. Seeds were not broken during initial juiciness assessments. The panelists evaluated seed presence and size by breaking the fruit apart with their tongues. Firmness and astringency were evaluated with the flavor attributes.
Flavor	
Sweet & Sour Standards	Swish the solution around in your mouth for 5 sec and spit the solution out. Focus on the intensity of the solutions while they were present in the mouth over the 5 sec. Rest 1 min between re-sampling and cleanse your palate with a bite of water cracker and distilled water.
Grassy & OSFI Standards	Swish the solution around in your mouth for 10 sec while holding your breathe. Focus on flavor presence and intensity of the aromatic notes while slowly breathing out your nose. Rest 1 min between re-sampling and cleanse your palate with a bite of water cracker and distilled water.
Earthy Standards	Shake the bottle vigorously for 10 sec. Open the cap and while holding your nose squeeze air in the bottle gently into your mouth. Hold the inhaled in your lungs, release your hand from your nose and slowly breathe out through your nose. Focus on flavor presence and intensity of the aromatic notes while slowly breathing out your nose. Rest 1 min before re-sampling (smell water to help to remove the aroma).
Fruit Samples	Three fruits uniform in size, shape and color (purplish) were then placed on a spoon. The spoon was placed in the mouth and the fruit was squished to the roof of the mouth to evaluate firmness before moving the fruit around the mouth with the tongue to assess flavor attribute intensities[x]. Panelists swallowed the fruit at the end of the overall attribute assessment and evaluated astringency once swallowed.

[x] order of appearance of flavor attributes was sweet, sour, grassy, earthy, and overall saskatoon flavor intensity (OSFI)

Table 2.4: Mean[w] sensory scores (n = 3) for trained panel aroma, texture, and flavor attribute evaluations[x] of unstored saskatoon fruit from 'Thiessen', 'Northline', and 'Smoky'

Panel Season	Sensory Attribute		Cultivar		P-Value[y]
		'Thiessen'	'Northline'	'Smoky'	CV
2004	**Aroma**				
n=11	Fresh/Fruity	5.68a (0.31)	4.34b (0.31)	5.16ab (0.31)	0.005
	Grassy	4.10 (0.31)	4.03 (0.31)	3.83 (0.31)	0.815
	Musty	2.84 (0.35)	3.71 (0.35)	3.88 (0.35)	0.093
	Texture				
	Initial Juiciness	10.82 (0.56)	10.41 (0.56)	11.12 (0.56)	0.633
	Firmness	5.08b (0.34)	6.52a (0.34)	4.37b (0.34)	0.001
	Astringency	4.95a (0.38)	3.61ab (0.38)	3.09b (0.38)	0.007
	Flavor				
	Sweet	4.96b (0.36)	5.04b (0.36)	6.81a (0.36)	<0.0001
	Sour	6.59a (0.36)	5.67a (0.36)	3.12b (0.36)	<0.0001
	Grassy	4.83a (0.24)	5.46a (0.24)	3.68b (0.24)	<0.0001
	Earthy	2.70 (0.23)	2.68 (0.23)	2.06 (0.23)	0.062
	OSFI[z]	5.28 (0.33)	5.54 (0.33)	6.06 (0.33)	0.241
2005	**Aroma**				
n=12	Fresh/Fruity	6.14a (0.35)	5.10b (0.37)	5.41ab (0.35)	0.020
	Grassy	2.45a (0.27)	1.93b (0.27)	1.82b (0.27)	0.002
	Musty	2.39 (0.15)	2.25 (0.15)	2.50 (0.15)	0.468
	Texture				
	Initial Juiciness	9.00a (0.27)	8.20b (0.27)	9.33a (0.26)	0.001
	Firmness	5.81b (0.25)	6.75a (0.24)	4.98c (0.24)	<0.0001
	Astringency	2.99ab (0.19)	3.22a (0.19)	2.59b (0.19)	0.009
	Flavor				
	Sweet	7.27a (0.28)	6.29b (0.27)	7.74a (0.27)	<0.0001
	Sour	3.65b (0.23)	5.62a (0.22)	2.62c (0.23)	<0.0001
	Grassy	3.21a (0.17)	2.48b (0.17)	1.99c (0.16)	<0.0001
	Earthy	1.22a (0.10)	0.90ab (0.11)	0.77b (0.10)	0.003
	OSFI[z]	8.75 (0.17)	9.23 (0.17)	9.15 (0.16)	0.091

[w] mean values within the same row followed by different letters are significantly different ($p \leq 0.05$) based on Tukey's adjustment; values in parentheses refer to standard error of the mean (SEM) values

[x] trained panel evaluations reported in centimeters; all intensity measurements evaluated using 15 cm unstructured line scales anchored with 'not very at all' at 0 cm and 'very' at 15 cm

[y] P-values of cultivar main effect (CV)

[z] overall saskatoon flavor intensity (OSFI)

Table 2.5: Mean[w] scores of 2004 trained panel instrumental analyses (n = 3) of the unstored fruit from 'Thiessen', 'Northline', and 'Smoky'

Instrumental Analysis	**Cultivar**			
	'Thiessen'	**'Northline'**	**'Smoky'**	**SEM[x]**
SSC[y]	14.0b	14.6a	13.2c	(0.17)
TA[z]	0.384a	0.375a	0.173b	(0.02)
Initial pH	4.35c	4.41b	4.95a	(0.00)
SSC/TA	36.62b	39.38b	73.11a	(2.75)
L	11.49	11.83	11.37	(0.60)
C	32.84	30.30	20.08	(4.31)
h°	19.7	23.28	25.02	(3.31)
Firmness (Kg/g)	1.20	1.35	1.26	(0.09)
Moisture (%)	81.40b	79.43c	82.79a	(0.35)

[w] mean scores within the same row followed by different letters are significantly different ($p \leq 0.05$) based on Tukey's adjustments

[x] standard error of the mean (SEM) values

[y] soluble solids content (SSC) expressed as °Brix

[z] titratable acidity (TA) expressed as grams malic acid equivalents/100 g of berries

Table 2.6: Cultivar by storage treatment mean[w] instrumental analyses values of 'Thiessen', 'Northline', and 'Smoky' fruit prior to storage (Storage Assessment Treatment) and fruit evaluated by the trained panel over 5 d of storage at 4 °C (Trained Panel Treatment)

Storage Assessment Treatment[x]	Trained Panel Treatment[y]	Fruit Cultivar	SSC (°Brix)	TA (% malic eq.)	Initial pH	SSC/TA	Color[z] L	Color[z] C	Color[z] h°	Firmness (Kg/g)	Moisture (%)
5 d Pre-Stored	-	'Thiessen'	15.9	0.417b	3.94	38.74a	11.22b	1.64a	341.55a	0.94c	80.24a
		'Northline'	16.1	0.499a	3.97	32.38b	12.16a	1.24b	321.91b	1.68a	78.47b
		'Smoky'	15.8	0.426b	4.02	38.56a	12.28a	1.22b	323.23b	1.44b	78.69ab
		SEM	(0.49-0.51)	(0.021)	(0.04)	(2.21)	(0.36)	(0.09)	(3.32)	(0.082)	(0.45)
3 d Pre-Stored	-	'Thiessen'	15.8b	0.438b	3.91b	36.38b	10.92c	1.73a	320.43	0.99b	80.31a
		'Northline'	16.3b	0.540a	3.95b	30.53c	11.66b	1.01c	315.21	1.59a	78.73b
		'Smoky'	16.8a	0.326c	4.23a	51.72a	12.30a	1.37b	328.23	1.36a	78.77b
		SEM	(0.19-0.20)	(0.013)	(0.02)	(0.72)	(0.25)	(0.11)	(11.33)	(0.076)	(0.41)
-	5 d Stored	'Thiessen'	15.1b	0.364a	4.06c	42.93b	11.77b	1.91a	341.59a	1.21b	80.01a
		'Northline'	15.2b	0.376a	4.16b	42.65b	12.52a	1.16c	317.74b	1.52a	78.42b
		'Smoky'	16.3a	0.262b	4.42a	61.36a	12.57a	1.39b	334.45a	1.36ab	79.90a
		SEM	(0.29-0.34)	(0.028)	(0.03)	(2.50)	(0.16)	(0.14)	(3.32)	(0.049)	(0.44)
-	3 d Stored	'Thiessen'	15.0c	0.387b	4.04b	39.03b	11.66b	2.15a	333.44	1.10b	80.38a
		'Northline'	16.7b	0.481a	3.97c	35.24b	12.22b	1.17c	316.23	1.46a	78.31b
		'Smoky'	17.7a	0.296c	4.38a	60.53a	13.16a	1.42b	323.46	1.39a	79.44ab
		SEM	(0.45-0.46)	(0.011)	(0.03)	(1.49)	(0.49)	(0.07)	(9.77)	(0.040)	(0.36)
-	Unstored	'Thiessen'	15.4b	0.419a	4.01b	38.00b	11.87b	1.92a	326.67	1.03b	79.45
		'Northline'	14.5c	0.441a	4.06b	32.61c	11.76b	1.27b	324.35	1.37a	79.76
		'Smoky'	17.6a	0.312b	4.30a	57.99a	12.67a	1.42b	320.76	1.40a	78.67
		SEM	(0.46-0.48)	(0.019)	(0.03)	(3.41)	(0.51)	(0.14)	(7.55)	(0.042)	(0.46)

[w] mean scores of 3 replicates within the same storage treatment and analysis followed by different letters are significantly different ($p \leq 0.05$) based on Tukey's adjustment

[x] portions of the saskatoon fruit treatments prior to being placed in storage at 4 °C for 3 d and 5 d

[y] saskatoon fruit treatments stored for both 3 d and 5 d at 4 °C and unstored fruit evaluated by trained panelists in a single sitting

[z] L: lightness; C: chroma; h°: hue angle

Table 2.7a: Mean[w] scores of fruit from 'Thiessen', 'Northline', and 'Smoky' over 5 d of storage at 4 °C evaluated by the 2005 trained panel for aroma, texture, and flavor attributes[x] (non significant ($p > 0.05$) cultivar × treatment interactions attributes only)

Mixed Model Effect		**Sensory Attribute**					
		Aroma		**Texture**	**Flavor**		
		Fresh/Fruity	Grassy	Initial Juiciness	Grassy	Earthy	OSFI[y]
Cultivar	'Thiessen'	6.17a (0.17)	2.08a (0.10)	9.28a (0.11)	3.04a (0.15)	1.14a (0.09)	8.73b (0.09)
	'Northline'	5.06b (0.16)	1.70b (0.10)	8.58b (0.12)	2.42b (0.15)	0.86b (0.09)	9.14a ((0.09)
	'Smoky'	5.92a (0.16)	1.77b (0.10)	8.58b (0.12)	2.19b (0.15)	0.76b (0.09)	9.04ab ((0.09)
Duration of Storage at 4 °C	0 d	5.56 (0.16)	2.01j (0.10)	8.50k (0.12)	2.57 (0.15)	0.94 (0.09)	9.04 (0.09)
	3 d	5.77 (0.17)	1.69k (0.10)	9.01j (0.11)	2.49 (0.15)	0.95 (0.09)	8.96 (0.09)
	5 d	5.83 (0.16)	1.84jk (0.10)	8.93j (0.12)	2.58 (0.15)	0.87 (0.09)	8.91 (0.09)
P-Value[z]	**CV**	**<0.0001**	**0.001**	**<0.0001**	**<0.0001**	**<0.0001**	**0.006**
	TRT	**0.398**	**0.011**	**0.001**	**0.720**	**0.342**	**0.560**
	CV × TRT	**0.234**	**0.487**	**0.286**	**0.119**	**0.952**	**0.435**

[w] mean scores within the same attribute (column) followed by the letters 'abc' are significantly ($p \leq 0.05$) different based on Tukey's adjustment among the fruit from the 3 cultivars; mean scores within the same attribute (column) followed by the letters 'jkl' are significantly ($p \leq 0.05$) different based on Tukey's adjustment among the 3 duration of storage at 4 °C; numbers in brackets following mean scores are standard error of the mean (SEM) values

[x] trained panel evaluation of aroma, texture, and flavor attributes reported in centimeters; all intensity measurements conducted on 15 cm unstructured line scales anchored with 'not very at all' at 0 cm and 'very' at 15 cm

[y] overall saskatoon flavor intensity (OSFI)

[z] P-values of cultivar (CV), storage treatment (TRT), and cultivar × storage treatment (CV × TRT) interaction

Table 2.7b: Mean[x] scores of fruit from 'Thiessen', 'Northline', and 'Smoky' over 5 d of storage at 4 °C evaluated by the 2005 trained panel for aroma, texture, and flavor attributes[y] (significant ($p \leq 0.05$) cultivar × treatment interactions attributes only)

Cultivar	Duration of Storage at 4 °C	Sensory Attribute				
		Aroma	Texture		Flavor	
		Musty	Firmness	Astringency	Sweet	Sour
'Thiessen'	0 d	2.18ab (0.14)	5.67c (0.22)	2.89bc (0.16)	7.25ab (0.20)	3.46cde (0.19)
	3 d	2.10ab (0.15)	5.73c (0.20)	3.55ab (0.16)	7.18ab (0.20)	3.70cd (0.18)
	5 d	2.58a (0.15)	6.67ab (0.21)	4.02a (0.16)	7.59a (0.21)	3.22de (0.19)
'Northline'	0 d	2.30ab (0.15)	6.73ab (0.21)	3.04bc (0.16)	6.31c (0.19)	5.30a (0.19)
	3 d	2.19ab (0.15)	7.13a (0.20)	2.52c (0.16)	6.58bc (0.21)	5.12ab (0.19)
	5 d	2.23ab (0.14)	6.98a (0.21)	3.06bc (0.16)	6.78bc (0.20)	4.40bc (0.18)
'Smoky'	0 d	2.31ab (0.14)	5.00c (0.21)	2.57c (0.17)	7.63a (0.20)	2.68ef (0.19)
	3 d	1.90b (0.14)	5.82bc (0.21)	2.92bc (0.17)	7.88a (0.21)	1.90f (0.19)
	5 d	1.79b (0.14)	5.93bc (0.22)	2.57c (0.17)	7.31ab (0.20)	2.03f (0.18)
P-Value[z]	**CV × TRT**	**0.027**	**0.042**	**0.000**	**0.029**	**0.028**

[x] mean scores within the same attribute (column) followed by different letters are significantly ($p \leq 0.05$) different among the fruit from the 3 cultivars; numbers in brackets following mean scores are standard error of the mean (SEM) values

[y] trained panel evaluation of aroma, texture, and flavor attributes reported in centimeters; all intensity measurements conducted on 15 cm unstructured line scales anchored with 'not very at all' at 0 cm and 'very' at 15 cm

[z] P-values of cultivar × storage treatment (CV × TRT) interaction

Table 2.8: Storage treatment by cultivar mean[w] instrumental analyses values of ‘Thiessen’, ‘Northline’, and ‘Smoky’ fruit prior to storage (Storage Assessment Treatment) and fruit evaluated by the trained panel over 5 d of storage at 4 °C (Trained Panel Treatment)

Fruit Cultivar	Storage Assessment Treatment[x]	Trained Panel Treatment[y]	SSC (°Brix)	TA (% malic eq.)	Initial pH	SSC/TA	Color[z] L	Color[z] C	Color[z] h°	Firmness (Kg/g)	Moisture (%)
‘Thiessen’	5 d Pre-Stored	-	15.8ab	0.417a	3.94b	38.74	11.22ab	1.64b	341.55	0.94b	80.24
	3 d Pre-Stored	-	15.9a	0.438a	3.91b	36.38	10.92b	1.73b	320.43	0.99ab	80.31
	-	5 d Stored	14.9b	0.364c	4.06a	42.92	11.77a	1.91ab	341.59	1.21a	80.01
	-	3 d Stored	15.3ab	0.387bc	4.04a	39.03	11.66ab	2.15a	333.44	1.10ab	80.38
	-	Unstored	15.2ab	0.419ab	4.01ab	38.00	11.87a	1.92ab	326.67	1.03ab	79.45
		SEM	(0.32-0.37)	(0.0134)	(0.02)	(1.72)	(0.32)	(0.12)	(11.61)	(0.099)	(0.39)
‘Northline’	5 d Pre-Stored	-	16.1b	0.499b	3.97b	32.38bc	12.16ab	1.24a	321.91	1.68a	78.47b
	3 d Pre-Stored	-	16.3ab	0.540a	3.95b	30.53c	11.66ab	1.01b	315.21	1.59ab	78.73ab
	-	5 d Stored	15.3c	0.376d	4.16a	42.65a	12.52a	1.16ab	317.74	1.52bc	78.42b
	-	3 d Stored	16.9a	0.481b	3.97b	35.24b	12.22ab	1.17ab	316.23	1.46bc	78.31b
	-	Unstored	14.3d	0.441c	4.06b	32.61bc	11.76b	1.27a	324.35	1.37c	79.76a
		SEM	(0.34-0.39)	(0.025)	(0.03)	(1.34)	(0.19)	(0.09)	(3.41)	(0.043)	(0.42)
‘Smoky’	5 d Pre-Stored	-	15.5c	0.426a	4.02d	38.56c	12.28b	1.22	323.23b	1.44	78.69
	3 d Pre-Stored	-	16.5b	0.326b	4.23c	51.72b	12.30b	1.37	328.23ab	1.36	78.77
	-	5 d Stored	16.0bc	0.262c	4.42a	61.36a	12.57ab	1.39	334.45a	1.36	79.90
	-	3 d Stored	17.4a	0.296bc	4.38ab	60.53a	13.16a	1.42	323.46b	1.38	79.44
	-	Unstored	17.6a	0.312b	4.30bc	57.99a	12.67ab	1.42	320.76b	1.40	78.67
		SEM	(0.33-0.36)	(0.021)	(0.03)	(3.07)	(0.24)	(0.10)	(4.65)	(0.054)	(0.53)

[w] mean scores of 3 replicates within the same cultivar and analysis followed by different letters are significantly different ($p \leq 0.05$) based on Tukey's mean separation

[x] portions of the saskatoon fruit treatments prior to being placed in storage at 4 °C for 3 d and 5 d

[y] saskatoon fruit treatments stored for both 3 d and 5 d at 4 °C and unstored fruit evaluated by trained panelists in a single sitting

[z] L: lightness; C: chroma; h°: hue angle

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3. Saskatoon Fruit (*Amelanchier alnifolia* Nutt.) Quality Over Five Days of Storage at 4 °C Part II: Consumer and Instrumental Evaluations

3.1 Introduction

The saskatoon (*Amelanchier alnifolia* Nutt.) is a small fruit crop native to areas of North America (Harris 1972; St. Pierre 1992) with a unique flavor (benzaldehyde being a major component) (Mazza and Hodgins 1985; Lutz 1994) and a reputation of being a highly perishable fresh commodity (Williams 1994; Rogiers and Knowles 1998, 2000). Given the difficulties of maintaining optimal flavor and aroma levels once harvested, the majority of saskatoon fruit is currently sold fresh through u-pick operations or processed into value-added products such as jams, jellies, wines, syrups, and juice (Lutz 1994; Faye and Chaudhary 2001).

As consumption of fresh fruit is becoming more widely recognized as a means of maintaining a healthy lifestyle (Southon and Faulks 2002), health promoting attributes such as anthocyanin and mineral content (Green and Mazza 1986; Mazza 1986, 2004; Hu and others 2005; Zatylny and others 2005) make the unprocessed saskatoon fruit an excellent candidate for a novel marketable small horticultural crop in and outside of Canada. Over the past few decades, the saskatoon fruit has gained substantial presence in the Western Canadian small fruit market. Recent estimates indicate a 40% increase in acres planted in Alberta, Canada from 1999 to 2005 (Hausher 2006). Approximately 2 million pounds of fresh saskatoon fruit are produced per season in Alberta. Preparation for this expansion in the saskatoon fruit industry has resulted in research focusing on fruit growth and development (Olson and Steeves 1982; McGarry and others 1998, 2001, 2005), epidemiology (Pluim and others 1994; Ronald and others 2001), ripening physiology (Rogiers 1997), and fruit chemistry (Knowles and Rogiers 1997). Phytochemical composition (Green and Mazza 1986; Mazza 1986; Hu and others 2005; Zatylny and others 2005), fresh shelf-life extension (Rogiers and Knowles 1998, 2000; Zatylny and St. Pierre 2002), long term preservation (Stephenson and others 2002; Yakimishen and others 2001), consumer evaluation of jelly (Mazza 1979), and sensory evaluation of processed juice (Lutz 1994) and pie filling (Ziehl and St. Pierre 2001) have also been examined. However, sensory evaluation of unprocessed saskatoon fruit has never been conducted. This knowledge would enhance the marketability of this crop as no evaluations have been performed to compare consumer acceptance of saskatoon fruit from different commercial cultivars or to evaluate consumer acceptance over fresh shelf-life.

The large fresh weight gain that occurs in conjunction with ripening of saskatoon fruit makes it unfeasible and uneconomical to harvest the fruit before they are fully ripe (Rogiers and Knowles 1997, 1999, 2000; Rogiers and others 1998; McGarry and others 1998). As such, sensory evaluation of fresh saskatoon fruit is limited to the short season (4 wk) in which fruit is fully ripe and is complicated by fruit from different cultivars been fully ripe at different times through out the season. Seasonal variability in the commencement of ripening due to environmental factors such as temperature also complicates sensory evaluation of this fruit.

Considering the constraints of conducting sensory evaluation with unprocessed saskatoon fruit, the objectives of this research were to gain knowledge of local consumer acceptance of fruit from common commercially produced cultivars and to explore the quality changes of the fruit from each cultivar over 5 d of storage at 4 °C, as well as to identify the most preferred fruit cultivar for local fresh fruit marketing. Also, we set out to gain preliminary knowledge of consumer perceptions of saskatoon fruit and appropriate positioning and pricing of this fresh product in the domestic market.

3.2 Materials and Methods

3.2.1 Fruit Storage Conditions and Sample Preparation

For each of the cultivars ('Thiessen', 'Northline', and 'Smoky'), 9 kg of ripe fruit were harvested both 3 d and 5 d in advance and stored at 4 °C in 11.3 L Rubbermaid® containers

(Newell Rubbermaid, Mississauga, ON., Canada) (4.5 kg per container) for comparison to unstored fruit during a single sitting. Instrumental analyses were conducted on the fruit from each cultivar prior to storage for both 3 d and 5 d to assess the effects of storage on soluble solids content (SSC), titratable acidity (TA), initial pH, firmness, percent moisture, and color. The stored and unstored fruit from each cultivar evaluated by the consumers were also subjected to the same instrumental analyses.

The fruit (40 g of each) for consumer panel evaluation were sorted and packaged in 120 mL styrofoam cups with lids and were held at room temperature (21 °C) overnight prior to evaluation the following day. The unstored fruit treatments from each cultivar were evaluated within 26 to 34 h of harvest. All of the fruit treatments (n = 3) from each cultivar were randomly assigned different 3-digit codes for each evaluation session (n = 3).

3.2.2 Sensory Evaluation

All research protocols were approved by the Research Ethics Board, Faculty of Agriculture, Forestry and Home Economics at the University of Alberta, Edmonton, AB, Canada (See Appendices, Section 5.2.1).

3.2.2.1 Consumer Evaluations

One hundred and fifty-nine consumers (104 females and 55 males, aged 18 to 76+ y) were recruited at a local gardening center over 2 weekends during the 2005 fresh saskatoon fruit season. Forty-six, 61, and 56 participants provided their opinions about the acceptability of fruit stored for both 3 d and 5 d and unstored fruit of ‘Thiessen’, ‘Northline’, and ‘Smoky’, respectively. To participate in the study interested consumers were asked, “Do you like fresh saskatoon fruit? Do you eat them at least once a summer?”. Consumers with allergies, intolerances, or sensitivities to saskatoon fruit or the unsalted saltine crackers (Sunfresh Ltd., ON, Canada) were asked not to participate.

Prior to evaluation of the saskatoon fruit treatments (n = 3), each participant completed a use and opinion survey (See Appendices, Section 5.2.2.4). The survey queried frequency of consumption, common forms of fresh and processed fruit consumption, acquisition of fresh saskatoon fruit, and willingness to pay for saskatoon fruit in and out of season.

Acceptability evaluations were conducted under incandescent lighting using cardboard partitions to ensure individual assessment. Paper ballots (See Appendices, Section 5.2.3.5) were used for data collection and order of presentation of the samples was randomized and balanced for 120 panelists in blocks of 10. Consumers were provided with a tray containing the 3 fruit samples, a napkin, 3 spoons, a glass of distilled water, and 2 unsalted saltine crackers. Acceptability of the fruit from each cultivar was rated for appearance, aroma, texture, flavor, and overall opinion on 9 point hedonic scales. Five point just-about-right (JAR) scales were also used to evaluate sweetness and saskatoon fruit flavor. Comment sections were provided for those that wanted to elaborate on their scale ratings.

3.2.2.2 Use and Opinion Survey

In addition to the gardening center participants, consumers at local specialty (n = 39) and conventional (n = 61) grocery stores completed the same use and opinion survey. Interested participants provided informed consent and were asked the same screening questions. No fruit samples were evaluated by these participants. The purpose of completion of the surveys at these locations was to gain preliminary knowledge about potential product placement of unprocessed saskatoon fruit.

3.2.3 Instrumental Analyses

Instrumental analyses were conducted in conjunction with sensory evaluation. Fruit samples were evaluated for firmness, color, and percent moisture prior to storage at 4 °C for both 3 d and 5 d and on the day of panel evaluations (3 replicates per treatment). Fruit prior to both 3 d and 5 d of storage (pre-stored fruit) were frozen (-25 °C) the day of procurement and the fruit evaluated by the panels were frozen (-25 °C) the day of evaluation for SSC and TA analyses. The methods for instrumental analyses are outlined in Chapter 2 (refer to 2005 instrumental methods).

3.2.4 Statistical Analyses

The data was analyzed by an analysis of variance (ANOVA) using SAS® version 9.1 (SAS Institute Inc., Cary, NC, U.S.A.). The main effects, treatment [stored (3 d and 5 d) and unstored fruit evaluated by the consumers] and cultivar ('Thiessen', 'Northline', and 'Smoky') were considered fixed. The cultivar × treatment interactions were tested for significance ($p \leq 0.05$) within the sensory data. The fruit treatments prior to storage ("pre-stored" fruit) for both 3 d and 5 d were also included in the instrumental analyses data. PROC MIXED (SAS) was used analyze the sensory and instrumental data and least square means were separated ($p \leq 0.05$) using Tukey's adjustment. Chi-square (PROC CATMOD) was used to analyze the categorical consumer use and opinion survey data.

3.3 Results and Discussion

3.3.1 Consumer Acceptance

Evaluation of consumer acceptance of the fruit from the 3 saskatoon cultivars was important to characterize the desirable attributes in saskatoon fruit and to investigate cultivar preference. In addition, consumer acceptance of the unstored fruit can be used to benchmark consumer expectations of freshly harvested saskatoon fruit. As storage duration influences degree of quality deterioration in horticultural commodities (Shewfelt and Prussia 1993; Kader 2003), it was important to compare acceptance of unstored fruit and fruit stored over a realistic fresh market time frame.

The cultivar × treatment interactions within each of the acceptability and JAR ratings were not significant ($p > 0.05$), with the exception of the appearance acceptability rating interaction. The mean acceptability and JAR ratings with non significant ($p > 0.05$) cultivar × treatment interactions are presented in Table 3.1a while the mean appearance acceptability ratings with a significant ($p \leq 0.05$) cultivar × treatment interaction are presented in Table 3.1b.

Regardless of 5 d of storage at 4 °C, the mean aroma ratings were not significantly ($p > 0.05$) different among the fruit from the 3 cultivars (Table 3.1a). Mean aroma ratings between 'neither like nor dislike' and 'like slightly' given to the fruit from each cultivar were supported by consumer comments that they were unable to detect any aroma in the fruit from the 'Northline' and 'Smoky' treatments evaluated. Fewer comments regarding lack of aroma in the fruit from the 'Thiessen' treatments evaluated were collected.

The mean appearance ratings of the fruit from 'Thiessen' decreased ($p \leq 0.05$) after 5 d of storage at 4 °C whereas the mean ratings of the fruit from 'Northline' and 'Smoky' did not change ($p > 0.05$) as a result of storage (Table 3.1b). Consumers commented that the fruit stored for 5 d from 'Thiessen' looked shriveled. Over storage the mean appearance ratings ranged between 'like slightly' and 'like moderately' within the fruit treatments from each of the cultivars. Consumers commented that the consistent size (small) of the fruit from 'Smoky' was appealing while the large size of the fruit from 'Thiessen' was also considered to be positive.

After 5 d of storage at 4 °C, the mean flavor ratings of the stored fruit from each cultivar did not change ($p > 0.05$) compared to the unstored fruit (Table 3.1a). Fruit from each cultivar maintained mean flavor ratings between 'like slightly' and 'like moderately' over storage. Mean flavor acceptability and JAR saskatoon fruit flavor ratings indicated that fruit from 1 cultivar was not preferred ($p > 0.05$) over another; however, mean ratings of JAR sweetness among the fruit from the cultivars indicated that consumers found the fruit from 'Smoky' maintained levels of sweetness significantly ($p \leq 0.05$) closer to 'just-about-right' than the fruit from 'Thiessen'. Regardless of storage, the mean JAR saskatoon fruit flavor ratings of fruit from each cultivar were below 'just-about-right'. Comments were divided as to whether fruit from any of the cultivars evaluated possessed their ideal perceptions of saskatoon fruit flavor. After both 3 d and 5 d of storage, the mean JAR sweetness and saskatoon fruit flavor ratings within fruit from each of the cultivars declined ($p \leq 0.05$) to levels below 'just-about-right'.

Mean hedonic ratings for texture within the fruit from each cultivar did not change ($p > 0.05$) as a result of 5 d of storage at 4 °C (Table 3.1a). Each cultivar stored over the 5 d received mean texture ratings between 'like slightly' and 'like moderately'. Regardless of storage, the fruit from 'Smoky' received a higher ($p \leq 0.05$) texture acceptability rating than the fruit from 'Thiessen'. Based on mean overall opinion ratings, consumers found the unstored fruit treatments within each of the cultivars to be more ($p \leq 0.05$) acceptable than fruit stored for both 3 d and 5 d. Among the cultivars, the fruit from 'Smoky' maintained a higher ($p \leq 0.05$) mean overall opinion rating than the fruit from 'Thiessen' over the 5 d of storage.

Based on the consumer acceptance and JAR ratings, the fruit from 'Smoky' were preferred more than the fruit from 'Thiessen'. Given the significant ($p \leq 0.05$) decline in appearance of fruit stored for 5 d from 'Thiessen' compared to its fresh counterpart, it is evident that this cultivar would be less desirable for fresh marketing. When subjected to 5 d of storage at 4 °C, the fate of the fruit from each cultivar was the same. Storage of the fruit for both 3 d and 5 d resulted in a significant ($p \leq 0.05$) decline in the consumers' overall opinions of the fruit and perceptions of 'just-about-right' levels of sweetness and characteristic saskatoon fruit flavor.

With the exception of aroma, fruit from all of the cultivars over the 5 d of storage at 4 °C received mean ratings between 'like slightly' and 'like moderately'. Consumer acceptance studies with fresh apples (Jaeger and others 1998; Cliff and others 1999) have yielded similar mean hedonic ratings. Mean acceptance ratings between 6 and 7 on a 9 point hedonic scale are favorable for a fresh commodity. Although mean consumer acceptability ratings of the fruit from 'Thiessen', 'Northline', and 'Smoky' over the 5 d of storage at 4 °C were similar, it was important to examine all aspects that influence consumers' perspectives of quality.

Aroma and appearance acceptance are important in maintaining overall quality of a fresh product as consumers use these characteristics to assess the initial quality of the fruit at the point of purchase (Prussia and Shewfelt 1993; Kader 1999; Jaeger and others 2003a). While maintenance of consumer confidence in the product is largely dependent on flavor (Prussia and

Shewfelt 1993; Kader 1999, 2001), acceptance of texture is also an important sensory characteristic (Prussia and Shewfelt 1993) although consumers only tend to notice texture when unacceptable (Szczesniak and Kahn 1971). As the hierarchy of importance that consumers assign to quality attributes such as, aroma, appearance, flavor, and texture when assessing a fruit product can vary (Moskowitz and Krieger 1993; Prussia and Shewfelt 1993; Cliff and others 1999; Jaeger and others 2003ab, 2005), all of these attributes should be considered equally important in maintaining consumer acceptance.

3.3.2 Use and Opinion Survey

The results of the use and opinion survey are summarized in Table 3.2. Saskatoon fruit is a well established summer fruit most frequently consumed between 1 to 5 times per season by local consumers (n = 259; 72% female and 28% male) between 46 to 65 y of age. Attributes that the participants liked best about saskatoon fruit were divided into 9 categories: taste or flavor, other specified sensory characteristics, nostalgia, health, cost and availability, association with prepared foods, crop management concerns, and 'other'. Sixty-nine percent of all the participants mentioned flavor or taste as a driver behind their liking of saskatoon fruit while 6% to 13% mentioned reasons that fit into the remaining 8 categories.

Although specialty store participants reported significantly ($p \leq 0.05$) higher annual household taxable incomes compared to the gardening center participants, no differences ($p > 0.05$) were detected among the locations for willingness to pay for a 300 g container of fresh saskatoon fruit Forty-seven percent of all the participants most frequently chose $3.00 to $4.00 ($10.00 to $13.33 per fresh kg) as the price that they would be willing to pay for the 300 g container. According to Faye and Chaudhary (2001), the highest average price per kilogram local saskatoon fruit producers receive is $6.23 per kg at farmers' markets. As such, saskatoon fruit producers may be able to receive a higher price for fresh saskatoon fruit sold to local grocery stores. However, more research regarding appropriate pricing should be conducted to include contextual influences of willingness to pay (Lawless and Heymann 1998; Moskowitz and others 2005).

The opportunity to purchase fresh saskatoon fruit out of season was met positively by 83% of all consumers. However, common reasons given by the participants not willing to buy fresh saskatoon fruit out of season included concerns about high price and fresh quality of the fruit, their preference for other fruits at that time of year, and the fact that they would use processed fresh saskatoon fruit until the next fresh season. Thus packaging regimes such as modified atmosphere packaging (MAP) that can place a product on the market out of its fresh season may have limitations in the local market.

Effective placement of saskatoon fruit into the mainstream grocery market is dependent on many factors. The context of consumption of fresh fruit is an important factor to understand consumer purchase intention. Nearly 50% of participants at each location stated that they obtained fresh saskatoon fruit in the wilderness. Additionally, a large portion of consumers indicated that they were using prior experiences with wild saskatoon fruit as a reference against which they evaluated the commercial fruit presented in this study. This comparison to the perceived more flavorful wild counterpart could be one cause for the mean JAR flavor ratings being below the ideal JAR point for all the cultivars and storage treatments.

Fresh commercially produced saskatoon fruit in grocery stores may not be well received by local consumers who are accustomed to obtaining saskatoon fruit in the wilderness and at farmers' market and u-pick operations. As past experiences can influence and possibly exaggerate consumers' expectations of quality, (Cubero and others 1995; Harker and others 2003) a more appropriate target market for fresh saskatoon fruit may be consumers who are interested in both the beneficial health properties of saskatoon fruit and in trying novel foods.

3.3.3 Instrumental Analyses

3.3.3.1 Pre-Stored and Unstored Fruit

While the SSC, TA, and initial pH values among the pre-stored fruit (3 d and 5 d) and unstored fruit evaluated by the consumers from 'Thiessen' were not consistent ($p \leq 0.05$), the SSC/TA ratios of the pre-stored (3 d and 5 d) and unstored fruit from 'Thiessen' were not significantly ($p > 0.05$) different (Table 3.3). In 'Smoky', the SSC, TA, and initial pH values and the SSC/TA ratios of the pre-stored (3 d and 5 d) and unstored fruit were consistent ($p > 0.05$). While the SSC and initial pH values of the pre-stored (3 d and 5 d) and unstored fruit from 'Northline' were the same ($p > 0.05$), the TA values of the pre-stored (5 d) fruit were significantly ($p \leq 0.05$) higher than the values of the unstored fruit evaluated by the consumers. As such, the SSC/TA ratio of the pre-stored (5 d) fruit from 'Northline' had a significantly ($p \leq 0.05$) lower SSC/TA ratio than the unstored fruit evaluated by the consumers. Among the pre-stored (3 d and 5 d) and unstored fruit from each cultivar, the fruit from 'Smoky' possessed significantly ($p \leq 0.05$) greater SSC/TA ratios than the fruit from the 'Thiessen' and 'Northline' (Table 3.4).

Within the cultivars, significant ($p \leq 0.05$) differences in instrumental firmness and moisture among the pre-stored (3 d and 5 d) and unstored fruit were noted (Table 3.3). The unstored fruit from 'Northline' and 'Smoky' evaluated by the consumers were firmer ($p \leq 0.05$) than the pre-stored (3 d and 5 d) fruit from 'Northline' and 'Smoky', respectively. No significant ($p > 0.05$) differences were noted among the percent moisture values of the pre-stored (3 d and 5 d) and unstored fruit within 'Northline' and 'Smoky'. The unstored fruit from 'Thiessen' evaluated by the consumers were significantly ($p \leq 0.05$) firmer and maintained higher ($p \leq 0.05$) percent moisture values than the pre-stored (5 d) fruit from 'Thiessen'. Among the cultivars, the pre-stored (3 d and 5 d) and unstored fruit of 1 cultivar were not consistently the most firm or moist (Table 3.4). Although differences ($p \leq 0.05$) were observed among the instrumental color measurements (lightness (L) and chroma (C) and hue (h^o) values) of the pre-stored (3 d and 5 d) and unstored fruit within and among each of the cultivars (Tables 3.3 and 3.4), no practical color difference were notable.

3.3.3.2 Fruit Over 5 Days of Storage at 4 °C

General trends among the cultivars in SSC and initial pH values of the pre-stored (3 d and 5 d) and stored fruit (3 d and 5 d) of each cultivar were not noted (Table 3.3). However, within each cultivar, similar trends in TA values and SSC/TA ratios among the pre-stored (3 d and 5 d) and stored fruit (3 d and 5 d) were observed. In all cases, the TA values decreased ($p \leq 0.05$) in the fruit after storage, with the exception of the pre-stored (3 d) and stored (3 d) fruit from 'Smoky'. Within each cultivar, the TA reduction with storage for both 3 d and 5 d resulted in higher ($p \leq 0.05$) SSC/TA ratios. Once again, the SSC/TA ratios the pre-stored (3 d) and stored (3 d) fruit from 'Smoky' were an exception to the trend ($p > 0.05$). Regardless of storage prior to and after both 3 d and 5 d, the fruit from the 'Smoky' maintained the lowest ($p \leq 0.05$) TA values and the highest ($p \leq 0.05$) initial pH values of all the cultivars, accounting for the significantly ($p \leq 0.05$) higher SSC/TA ratios of the fruit treatments from 'Smoky' compared to the other cultivars (Table 3.4).

Compared to the analogous pre-stored fruit, fruit stored for 5 d from 'Thiessen' and 'Northline' became firmer ($p \leq 0.05$) while the firmness of fruit stored for 3 d from 'Smoky' significantly ($p \leq 0.05$) increased (Table 3.3). Percent moisture levels within all of the cultivars, regardless of storage for both 3 d and 5 d, remained consistent ($p > 0.05$) compared to the analogous pre-stored fruit. Among the pre-stored (3 d and 5 d) and stored (3 d and 5 d) fruit from each of the cultivars, no trend in level of firmness or moisture levels was noted (Table 3.4). Within and among the fruit treatments prior to and after storage from each of the cultivars, no trend in L, C, and h° values existed (Tables 3.3 and 3.4). Regardless of storage duration, fruit from all of the cultivars could be described as being bluish-purple (270° to 360°) in surface color (h°).

3.3.4 Experimental Design Considerations

Traditional sensory studies that require consumers to evaluate a product from a single batch over time, referred to as a partially staggered design (Gacula 1975; Kilcast and Subramaniam 2000), can be costly, time consuming, and require a large number of participants (Gacula 1975). Gámbaro and others (2004), given the unfeasible and costly nature of assembling consumers for multiple evaluative sessions, employed a storage design that allowed consumers to assess bread over 17 d of storage in a single session. Considering the constraints of a traditional storage design and the short window of opportunity to conduct sensory work with saskatoon fruit during the fresh season, the chosen experimental design in this study was fundamental to collecting reliable data as it allowed consumers to evaluate all the fruit treatments in a single sitting.

Variability between fruit from the same cultivar and even within a single fruit is inherent to horticultural commodities (Dever and others 1995; Abbott 1999) and is a complicating factor in sensory evaluation of fresh produce (Heintz and Kader 1983: Jaeger and others 2003b). Seasonal variability is also common due to preharvest factors such environmental conditions and cultural practices (Ferguson and others 1999; Kays 1999; Mattheis and Fellman 1999; Sams 1999). Therefore, regardless of strict adherence to postharvest handling systems, such as the "cold chain" (Kader 2003) to ensure consistent quality of a commodity, inconsistency in quality will exist. Taking natural variability into consideration, differences ($p \leq 0.05$) in the instrumental measurements of SSC/TA, firmness, percent moisture, and color among the pre-stored fruit (3 d and 5 d) and unstored fruit evaluated by the consumers were considered to be estimates of the validity of the chosen storage design.

As observed in the SSC/TA ratios of fruit from each cultivar prior to and after storage, the SSC/TA ratios of the fruit stored for both 3 d and 5 d evaluated by the panel were significantly ($p \leq 0.05$) higher than the SSC/TA ratios of the unstored fruit evaluated by the panel, with the exception of the fruit from 'Smoky' (Table 3.3). As the SSC/TA ratios of the pre-stored fruit (3 d and 5 d) and unstored fruit evaluated by the consumers within each of the cultivars were similar, the SSC/TA ratio indicates that consumers experienced the changes in sweet and sour tastes as they would have if the fruit had not been stored in advance. Although the sweet-sour relationship (SSC/TA ratio) plays a large role in the flavor acceptability of fruit products (Whiting 1970; Abbott and others 2004; Marsh and others 2006), Abbott and others (2004) demonstrated that the ratio of SSC/TA does not necessarily coincide with flavor acceptability ratings. Therefore, the increase in the SSC/TA ratios of the fruit due to storage does not necessarily concur with flavor acceptability within the cultivars.

Abbott and others (2004) found that instrumental analyses of texture in apples (force and deformation measurements) were not indicative of texture acceptability. As human perception of texture is multifaceted (Meilgaard and others 1991) the discrepancy in firmness and moisture levels of the pre-stored fruit (3 d and 5 d) and unstored fruit evaluated by the consumers (Table 3.3) may partially explain the lack of change in the mean texture acceptability ratings of the unstored and stored fruits evaluated by the consumers within each of the cultivars. Consumers did not comment on any observed color differences among the unstored and stored fruit, thus significant ($p \leq 0.05$) differences among the pre-stored fruit (3 d and 5 d) and unstored fruit evaluated by the consumers within the cultivars based on color are not a defining characteristic of experimental validity.

Consumer completion of the use and opinion survey indicated that flavor or taste was a driver behind consumer liking of saskatoon fruit. As flavor is not fully defined by the SSC/TA ratio of the fruit, the measurement of JAR saskatoon fruit flavor was useful in characterizing flavor acceptability. The instrumental measurements demonstrated that the chosen storage design worked well in fulfilling the objective of obtaining complete evaluations of the acceptance of the fruit over storage during the short fresh season. As such, this storage design could be applied to studies examining the fresh shelf-life of other horticultural products when time or subject participation is limited.

3.4 Conclusion

The results of this study examining consumer acceptance, use, and opinions of the fresh saskatoon fruit can be applied to future work with saskatoon fruit. The experimental design allowed consumers to evaluate all the storage treatments in a single sitting and was validated by the instrumental SSC/TA ratio measurements, which increased ($p \leq 0.05$) within each cultivar as a result of 5 d of storage at 4 °C. Although the fruit from 'Thiessen' was not considered to be as desirable as the fruit from 'Smoky' by the consumers in this single season study, further research on the suitability of various cultivars for fresh fruit market is warranted. No significant ($p > 0.05$) difference existed among the specialty and conventional grocery store participants and the gardening center participants based on willingness to pay for the 300 g container of saskatoon fruit. Although local consumers are willing to pay a higher price for fresh saskatoon fruit in grocery stores compared to farmers' markets, the context in which they are accustomed to obtaining this fruit needs to be taken into consideration when assessing market potential. Strong expectations of 'wild' flavor among local consumers familiar with saskatoon suggests that markets consisting of consumers unfamiliar with this fruit should be explored given the health promoting attributes and unique flavor of the saskatoon fruit. As local consumers' mean overall opinion and JAR saskatoon flavor ratings of fruit from each of cultivars declined ($p \leq 0.05$) as a result of both 3 d and 5 d of storage at 4 °C, future research regarding maintenance of fresh fruit acceptability and market potential needs to be performed.

Table 3.1a: Mean hedonic and just-about-right (JAR) ratings[w][x] of the fruit from 'Thiessen', 'Northline', and 'Smoky' stored at 4 °C over 5 days (non significant ($p > 0.05$) cultivar × treatment interactions ratings only)

Main Effects		Acceptability Rating					
		Aroma	**Flavor**	**JAR Sweetness**	**JAR Flavor[y]**	**Texture**	**Overall Opinion**
Cultivar	'Thiessen'	6.1 (0.12)	6.5 (0.13)	2.6b (0.08)	2.6 (0.08)	6.1b (0.14)	6.1b (0.14)
	'Northline'	5.8 (0.10)	6.8 (0.11)	2.7ab (0.06)	2.6 (0.07)	6.4ab (0.11)	6.4ab (0.12)
	'Smoky'	5.8 (0.10)	6.8 (0.11)	2.8a (0.07)	2.6 (0.07)	6.6a (0.12)	6.6a (0.13)
Duration of Storage at 4 °C	0 d	6.1j (0.11)	7.0j (0.12)	2.9j (0.07)	2.7j (0.07)	6.5 (0.13)	6.7j (0.13)
	3 d	5.7k (0.11)	6.5k (0.12)	2.6k (0.07)	2.5k (0.07)	6.2 (0.13)	6.2k (0.13)
	5 d	5.9jk (0.11)	6.6jk (0.12)	2.6k (0.07)	2.5k (0.07)	6.3 (0.13)	6.2k (0.13)
P-Value[z]	**CV**	**0.104**	**0.119**	**0.027**	**0.848**	**0.034**	**0.038**
	TRT	**0.013**	**0.017**	**0.010**	**0.013**	**0.349**	**0.005**
	CV*TRT	**0.269**	**0.403**	**0.671**	**0.497**	**0.244**	**0.563**

[w] mean ratings within the same attribute (column) followed by the letters 'abc' are significantly ($p \leq 0.05$) different based on Tukey's adjustment among the fruit from the 3 cultivars; mean ratings within the same attribute (column) followed by the letters 'jkl' are significantly ($p \leq 0.05$) different based on Tukey's adjustment among the 3 duration of storage at 4 °C; numbers in brackets following mean ratings are standard error of the mean (SEM) values

[x] hedonic ratings were collected using 9 point hedonic scales; JAR ratings were collected using 5 point JAR scales

[y] 'just-about-right' saskatoon fruit flavor

[z] P-values of cultivar (CV), storage treatment (TRT), and cultivar × storage treatment (CV × TRT) interaction

Table 3.1b: Mean hedonic appearance ratings[wx] of the fruit from 'Thiessen', 'Northline', and 'Smoky' stored at 4 °C over 5 days (significant ($p \leq 0.05$) cultivar × treatment interactions ratings only)

Cultivar	**Duration of Storage at 4 °C**	**Acceptability Rating** **Appearance**
'Thiessen'	0 d	7.0a
	3 d	6.3ab
	5 d	5.9b
	SEM	(0.24)
'Northline'	0 d	6.5ab
	3 d	6.4ab
	5 d	6.8ab
	SEM	(0.19)
'Smoky'	0 d	6.7ab
	3 d	6.9a
	5 d	6.7ab
	SEM	(0.21)
P-Value[y]	**CV*TRT**	**0.013**

[w] mean ratings within the same attribute (column) followed by different letters are significantly ($p \leq 0.05$) different based on Tukey's adjustment; numbers in brackets following mean ratings are standard error of the mean (SEM) values

[x] hedonic ratings were collected using 9 point hedonic scales; JAR ratings were collected using 5 point JAR scales

[y] P-values of cultivar × storage treatment (CV × TRT) interaction

Table 3.2: Use and opinion survey results expressed as percentages among participants at all locations

Use and opinion Survey Categories	Location Specialty n = 39	 Conventional n = 61	 Gardening n = 159	 All n = 259
Gender				
Males	13	21	35	28
Females	87	79	65	72
Age Range				
18-25 y	3	3	5	4
26-35 y	10	0	11	9
36-45 y	18	23	18	19
46-55 y	26	25	31	29
56-65 y	33	30	23	26
66-75 y	3	11	10	9
+76 y	8	8	1	4
Annual Taxable Household Income				
< $71,190	30	49	50	47
$71,191-$115,739	20	22	25	24
> $115,740	50	29	25	29
Primary Grocery Shopper				
Males				
Yes	75	69	45	49
No	25	31	55	51
Females				
Yes	82	92	89	89
No	18	8	11	11
Frequency of Fresh Saskatoon Fruit Consumption in Season				
1-2 times/season	50	31	53	47
3-5 times/season	37	44	27	33
6-10 times/season	5	13	6	8
+10 times/season	8	11	13	12
Procurement of Fresh Saskatoon Fruit				
My own garden	10	11	16	14
Friend's/Relative's garden	23	18	13	15
U-pick farm	23	30	13	18
Farmers' market	54	20	29	31
Grocery store	28	18	22	22
In the wilderness	44	52	48	48
Other	10	2	4	5
Common Forms of Consumption Other than Fresh Saskatoon Fruit				
Thawed from frozen	33	36	27	30
In pies	85	79	79	80
In other baked products	36	18	30	28
In jams or jellies	62	49	59	57
As juice	3	8	7	7
Other	5	2	6	5
Main Reason for Eating and Enjoying Saskatoon Fruit				
Taste or Flavor	-	-	-	69
Other sensory specified characteristics	-	-	-	6
Nostalgia	-	-	-	7
Health	-	-	-	10
Cost and Availability	-	-	-	13
Association with Prepared Foods	-	-	-	13
Crop Management Concerns	-	-	-	1
Other	-	-	-	5
Willingness to Pay for a 300g Container of Fresh Saskatoon Fruit				
less than $3.00 (less than $10.00/kg)	5	27	25	22
$3.00 to $4.00 ($10.00 to $13.33/kg)	49	42	47	47
$4.00 to $5.00 ($13.33 to $16.67/kg)	38	27	21	25
$5.00 to $6.00 ($16.67 to $20.00/kg)	8	4	7	7
Willingness to Buy Fresh Saskatoon Fruit Out of Season (1-3 wk)				
Yes	87	89	79	83
No	13	11	21	17

Table 3.3: Mean[w] instrumental analyses values of 'Thiessen', 'Northline', and 'Smoky' fruit prior to storage (Storage Assessment Treatment) and fruit evaluated by the consumer panels over 5 d of storage at 4 °C (Consumer Panel Treatment)

Fruit Cultivar	Storage Assessment Treatment[x]	Consumer Panel Treatment[y]	SSC (°Brix)	TA (% malic eq.)	Initial pH	SSC/TA	Color[z]			Firmness (Kg/g)	Moisture (%)
							L	C	h°		
'Thiessen'	5 d Pre-Stored	-	17.4a	0.487a	3.97c	35.98b	11.38b	1.58b	336.73c	0.91c	79.05b
	3 d Pre-Stored	-	15.1c	0.436b	4.04b	34.99b	13.55a	2.09ab	345.09b	1.14bc	80.31ab
	-	5 d Stored	16.5b	0.417bc	4.10a	39.99a	11.90b	1.82ab	346.82b	1.42a	79.40ab
	-	3 d Stored	14.8c	0.389c	4.02b	38.53a	11.37b	1.83ab	353.02ab	1.21b	80.92ab
	-	Unstored	16.1b	0.485a	3.90d	33.42b	11.33b	2.23a	355.94a	1.27b	81.47a
		SEM	(0.15-0.24)	(0.00646)	(0.01)	(0.88)	(0.26)	(0.13)	(1.98)	(0.058)	(0.45)
'Northline'	5 d Pre-Stored	-	15.4	0.531a	3.94	29.80c	11.77bc	1.22bc	313.17ab	1.27b	78.79
	3 d Pre-Stored	-	15.2	0.470b	3.98	33.23bc	13.35a	1.42ab	320.62ab	1.25b	79.27
	-	5 d Stored	14.8	0.376c	4.07	40.40a	13.35a	1.55a	316.03ab	1.62a	78.03
	-	3 d Stored	16.0	0.387c	4.08	41.87a	12.87ab	1.37ab	300.92b	1.36b	78.84
	-	Unstored	16.2	0.464b	3.99	35.09b	11.36c	1.09c	332.92a	1.60a	79.68
		SEM	(0.26-0.42)	(0.00520)	(0.04)	(1.17)	(0.36)	(0.06)	(5.78)	(0.067)	(0.54)
'Smoky'	5 d Pre-Stored	-	15.4cd	0.286ab	4.28b	54.27b	11.94b	1.43a	334.84a	1.02b	78.95
	3 d Pre-Stored	-	15.6bcd	0.284b	4.28b	56.33b	11.95b	1.08b	308.28c	1.29b	78.32
	-	5 d Stored	15.0d	0.244c	4.39a	63.14a	12.87ab	1.46a	335.89a	1.34b	80.82
	-	3 d Stored	15.9bc	0.309a	4.32b	51.88b	12.35ab	1.36a	332.31a	1.60a	79.04
	-	Unstored	16.2ab	0.276b	4.35ab	59.06ab	13.04a	1.38a	321.43b	1.53a	79.90
		SEM	(0.16-0.24)	(0.00520)	(0.02)	(1.20)	(0.26)	(0.06)	(1.58)	(0.099)	(0.69)

[w] mean scores within the same cultivar and analysis followed by different letters are significantly ($p \leq 0.05$) different based on Tukey's mean separation

[x] portions of the saskatoon fruit treatments prior to being placed in storage at 4 °C for 3 d and 5 d

[y] saskatoon fruit treatments stored for both 3 d and 5 d at 4 °C and unstored fruit evaluated by trained panelists in a single sitting

[z] L: lightness; C: chroma; h°: hue angle

Table 3.4: Mean[w] instrumental analyses values of 'Thiessen', 'Northline', and 'Smoky' fruit prior to storage (Storage Assessment Treatment) and fruit evaluated by the consumer panels over 5 d of storage at 4 °C (Consumer Panel Treatment)

Storage Assessment Treatment[x]	Consumer Panel Treatment[y]	Fruit Cultivar	SSC (°Brix)	TA (% malic eq.)	Initial pH	SSC/TA	Color[z] L	C	h°	Firmness (Kg/g)	Moisture (%)
5 d Pre-Stored	-	'Thiessen'	17.4a	0.487b	3.97b	35.98b	11.38b	1.58a	336.73a	0.91b	79.05
		'Northline'	15.4b	0.531a	3.94b	29.80c	11.77ab	1.22b	313.17b	1.27a	78.79
		'Smoky'	15.4b	0.286c	4.28a	54.27a	11.94a	1.43a	334.84a	1.02ab	78.95
		SEM	(0.09)	(0.00811)	(0.02)	(1.31)	(0.12)	(0.06)	(3.81)	(0.055)	(0.41)
3 d Pre-Stored	-	'Thiessen'	15.2c	0.437b	4.04b	34.99b	13.55a	2.09a	345.09a	1.14	80.31
		'Northline'	15.6b	0.470a	3.98b	33.23b	13.35ab	1.42b	320.62b	1.25	79.27
		'Smoky'	15.9a	0.284c	4.28a	56.33a	11.95b	1.08c	308.28c	1.29	78.32
		SEM	(0.08)	(0.00383)	(0.02)	(0.44)	(0.42)	(0.06)	(1.96)	(0.100)	(0.50)
-	5 d Stored	'Thiessen'	16.6a	0.417a	4.10b	39.99b	11.9	1.82	346.82a	1.42	79.40ab
		'Northline'	15.1b	0.376b	4.07b	40.40b	13.35	1.55	316.03b	1.62	78.03b
		'Smoky'	15.3b	0.244c	4.39a	63.14a	12.87	1.46	335.89a	1.34	80.82a
		SEM	(0.26)	(0.00529)	(0.05)	(1.43)	(0.12)	(0.12)	(4.18)	(0.078)	(0.42)
-	3 d Stored	'Thiessen'	14.3b	0.387a	4.02b	38.53b	11.37b	1.83a	353.02a	1.21b	80.92
		'Northline'	16.0a	0.387a	4.08b	41.87b	12.87a	1.37b	300.92c	1.36ab	78.84
		'Smoky'	15.9a	0.309b	4.32a	51.88a	12.35a	1.36b	332.31b	1.60a	79.04
		SEM	(0.17)	(0.00825)	(0.02)	(1.39)	(0.22)	(0.08)	(0.87)	(0.067)	(0.56)
-	Unstored	'Thiessen'	16.1	0.485a	3.90c	33.42b	11.33b	2.23a	355.94a	1.27	81.47
		'Northline'	16.2	0.464a	3.99b	35.04b	11.36b	1.09c	332.92b	1.60	79.68
		'Smoky'	16.2	0.276b	4.35a	59.06a	13.04a	1.38b	321.43b	1.53	79.90
		SEM	(0.21)	(0.00829)	(0.01)	(1.54)	(0.15)	(0.07)	(3.61)	(0.078)	(0.71)

[w] mean scores within the same storage treatment and analysis followed by different letters are significantly ($p \leq 0.05$) different based on Tukey's mean separation

[x] portions of the saskatoon fruit treatments prior to being placed in storage at 4 °C for 3 d and 5 d

[y] saskatoon fruit treatments stored for both 3 d and 5 d at 4 °C and unstored fruit evaluated by trained panelists in a single sitting

[z] L: lightness; C: chroma; h°: hue angle

3.5 References

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4. SUMMARY AND CONCLUSIONS

The objectives of this research were as follows:

1) to develop aroma, texture, and flavor profiles of fruit from 3 common commercially available cultivars ('Thiessen', 'Northline', and 'Smoky') of fresh (unprocessed) saskatoon fruit over 3 consecutive seasons and to then use the profiles to monitor sensory changes in the fruit that occur over storage at 4 °C for 5 d (short-term refrigeration temperature).

2) to gain knowledge of local consumer acceptance of fruit from these common commercially produced cultivars over a short-term storage regime (5 d at 4 °C), to explore the quality changes of the fruit from each cultivar over storage, and to identify the most preferred fruit cultivar for local fresh fruit marketing.

3) to gain preliminary knowledge of consumer perceptions of saskatoon fruit and appropriate positioning and pricing of this fresh product in the domestic market.

As outlined in Kader's (2003) "cold chain" for horticultural commodities, temperature is a key factor for quality maintenance not only directly after harvest, but for transport and market presentation. The 4 °C storage temperature in this experiment was chosen as an acceptable temperature that should be applied to saskatoon fruit in a retail setting and in a consumer's home refrigerator to maintain quality over 5 d. As consumer acceptance of quality dictates the success of a commodity in the market, the results of this local study indicate that the quality of this fresh fruit will deteriorate on the grocery store shelf and in the refrigerator of the consumer after 3 d if held at 4 °C. Although the current consumer acceptance study indicated that local consumers preferred 'Smoky' over 'Thiessen', the mean overall opinion and just-about-right (JAR) saskatoon fruit flavor ratings of each cultivar declined ($p \leq 0.05$) as a result of both 3 d and 5 d of storage at 4 °C. Based on the use and opinion survey completed by 259 local consumers of fresh saskatoon fruit during its short (4 wk) season, producers cannot expect to receive a higher price for saskatoon fruit through specialty stores. All local consumers at the specialty and conventional grocery stores and the gardening center were willing to pay a higher price ($10.00 to $13.33 per fresh kg) for fresh saskatoon fruit in grocery stores compared to farmers' markets ($6.23 per fresh kg). However, the context in which local consumers are accustomed to obtaining this fruit needs to be taken into consideration when assessing market potential. Regardless of storage, the mean JAR saskatoon fruit flavor ratings of each cultivar were below 'just-about-right' and consumer comments were divided as to whether any of the cultivars captured their perceptions of JAR saskatoon fruit flavor. As such, the history of consumption among local consumers of wild/uncultivated saskatoon fruit may hinder the success of local marketability of fresh cultivated saskatoon fruit.

The experimental design chosen to assess quality changes in the saskatoon fruit over 5 d of storage at 4 °C was similar to a consumer panel conducted with bread over storage (Gámbaro and others 2004). Although it is traditional to study the effects of storage on a commodity by having panelists assess the product chronologically, this approach has drawbacks (Gacula 1975; Heintz and Kader 1983). As a high consumer participation rate of a representative sample of the population of interest is required to collect meaningful data (Meilgaard and others 1991; Lawless and Heymann 1998; Stone and Sidel 2004), the traditional design can be expensive and impractical as it requires consumers for multiple sessions. Given the short fresh saskatoon fruit season, the chosen experimental design in this study was a compromise between the 2 requirements to collect reliable data. That is, it allowed consumers to evaluate the effect of both 3 d and 5 d of storage at 4 °C in a single sitting. Sixty-nine percent of consumers stated that flavor and taste were drivers of their liking of saskatoon fruit. Thus, monitoring soluble solids content/titratable acidity (SSC/TA) ratios of the fruit treatments prior to and after both 3 d and 5 d of storage helped to validate the experimental design. As observed in the SSC/TA ratios of fruit from each cultivar prior to and after storage in the consumer panel study, the SSC/TA ratios of the fruit stored for both 3 d and 5 d evaluated by the panel were significantly ($p \leq 0.05$) higher than the SSC/TA ratios of the fresh fruit evaluated by the panel, with the exception of the fruit from 'Smoky' (Table 3.3). Therefore, in conjunction with instrumental analyses, this storage design could be applied to studies examining the fresh shelf-life of other horticultural products when time or subject participation is limited.

Reliable aroma, texture, and flavor profiles of freshly harvested fruit from the 3 commonly produced cultivars ('Thiessen', 'Northline', and 'Smoky') of saskatoon fruit in Alberta, Canada were established over 3 consecutive fruit seasons. These fresh fruit baseline sensory profiles can aid in characterizing of fruit from other commercially produced saskatoon fruit cultivars and will prove to be useful as a benchmark to assess the fresh quality of future preservation technologies applied to saskatoon fruit. The examination of the influence of short term storage (5 d at 4 °C) on the sensory profiles of each of the saskatoon fruit cultivars demonstrates the usefulness of the profiles. The storage study indicated that the degree of change within the sensory profiles of the 3 fruit cultivars stored at 4 °C for 5 d was different. While fresh/fruity aroma, musty aroma, grassy aroma and flavor, earthy flavor, sweet taste, and overall saskatoon flavor intensity (OSFI) intensities of the fruit within each of the cultivars did not significantly ($p \leq 0.05$) change as a result of 5 d of storage, the initial juiciness of fruit from each cultivar stored for both 3 d and 5 d significantly ($p \leq 0.05$) increased compared to the fresh fruit treatments. After 5 d of storage, only the firmness and astringency intensities of 'Thiessen' significantly ($p \leq 0.05$) increased. While the malic acid equivalents of fruit from each cultivar consistent ($p \leq 0.05$) declined after 5 d of storage, the change in sour intensity was only perceivable ($p \leq 0.05$) in 'Northline' after the 5 d of storage. Although the OSFI did not differ ($p > 0.05$) among the unstored fruit from the 3 fresh cultivars, the fruit from 'Northline' possessed a significantly ($p \leq 0.05$) higher OSFI than the fruit from 'Thiessen' over the course of 5 d storage at 4 °C. As standardized protocols outlining handling, storage, preparation, and presentation for sensory evaluation of fruit and vegetables are not widely available it is the sincere hope of this author that the sensory protocol developed and refined over the 3 saskatoon fruit seasons will provide insight for future sensory studies involving saskatoon fruit and other fresh horticultural products.

With great public interest in consumption of fruit and vegetables (Southon and Faulks 2002), the health promoting attributes of saskatoon fruit such as anthocyanin and mineral content (Green and Mazza 1986; Mazza 1986, 2004; Hu and others 2005; Zatylny and others 2005) and its unique flavor (benzaldehyde being a major component) (Mazza and Hodgins 1985; Lutz 1994) make the unprocessed saskatoon fruit an excellent candidate for a novel marketable crop in and outside of Canada. As the current industry in Alberta, Canada is comprised of commercial producers that focus on value-added processing and smaller producers that facilitate u-pick operations and frequent farmers' markets (Faye and Chaudhary 2001), the saskatoon fruit producers of Alberta need to come together to discuss the concept of fresh fruit marketing. Following further research of applications to maintain the fresh quality of saskatoon fruit, a co-operative to pool fruit and facilities to maintain the quality large volumes of fruit (*e.g.* forced air coolers) and to sort and clean fruit before packaging could be considered. Additionally, standardized operating practices (SOPs) for postharvest management, orchard design, and the development of breeding programs could be developed by a saskatoon fruit co-operative.

Local consumers' expectations of the sensory attributes of saskatoon fruit appear to be based on their past experiences with this 'wild' fruit. As such, future research could include:

1) consumer acceptance testing of unprocessed saskatoon fruit with people unfamiliar with saskatoon fruit who are interested in health and trying novel products.

2) use of the sensory profiles to diversify the saskatoon fruit market into the fresh market by exploring how well preservation technologies such as modified atmosphere packaging (MAP) and edible coatings maintain fresh quality.

4.1 References

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5. Appendices

5.1 Trained Panel Forms

5.1.1 Application for Ethics Approval

Faculty of Agriculture, Forestry, and Home Economics

HUMAN RESEARCH ETHICS BOARD

APPLICATION FOR ETHICS APPROVAL

Date Submitted: ____June 7, 2005__

1. Investigator(s).

Wendy Wismer, Jocelyn Ozga, Kylie Kidd

2. University Department or institutional affiliation (if applicable), phone, FAX, e-mail. Provide this information for each investigator.

Wendy Wismer	Jocelyn Ozga	Kylie Kidd
Assistant Professor	Associate Professor	MSc Candidate
Agricultural, Food and Nutritional Science	Agricultural, Food and Nutritional Science	Agricultural, Food and Nutritional Science
Ph: 492-2923	Ph: 492-2653	Ph: 492-3833
Fax: 492-8914	Fax: 492-3239	Fax: 492-8914
wendy.wismer@ualberta.ca	jocelyn.ozga@ualberta.ca	kidd@ualberta.ca

3. Institution(s) through which the Research will be carried out:
University of Alberta, Agricultural, Food and Nutritional Science

4. Site(s) of data collection
   - room 2-35, Ag-For Centre, University of Alberta

5. Title of Project
   - **Trained panel sensory evaluation of saskatoon berries.**

6. Source of project funding:

(X) a granting agency - Alberta Value Added Corporation (AVAC), Alberta Crop Institute Development Fund (ACIDF), Alberta Agriculture Research Institute (AARI)
( ) a company (Please specify)
( ) other, (Please specify)

7. Anticipated date of commencement of project (Note that items 7-11 should comprise a maximum of 2 pages).

- It is anticipated that the trained panel evaluation will commence mid-July, with training two weeks prior. The exact start date is dependant upon the date of the saskatoon harvest.

8. Purpose and objectives of project
    - The overall purpose of this portion of the project is to develop an evaluation form and use it to characterize and quantify the sensory differences among three cultivars of saskatoon berries (Smoky, Northline and Thiessen) immediately after harvest and over five days of storage at 4°C. This will generate baseline data for evaluation of the berries in future years. The specific objectives of this project are to screen and train 10 to 12 panelists to generate a detailed profile of the sensory characteristics on which cultivars of saskatoon berries can be evaluated.

9. Rationale for this research
    - The saskatoon berry is rapidly gaining importance as a commercial fruit crop on the Canadian prairies. To date saskatoon fruits are not sold in large venues (*i.e.* supermarkets *etc.*) as fresh fruit because flavour and quality of the fruit degrades rapidly within days after harvest. By identifying the major flavour/odor components and developing modified-atmosphere packaging to maintain the flavour and texture of the fresh product, a large fresh market would be opened-up for the Alberta saskatoon growers to sell their product. This would greatly stimulate this horticultural industry as markets to sell the fruit are the limiting factor for further growth in this industry. In order to characterize the fresh berries and follow the changes that result from the modified atmosphere packaging, sensory profiles of the berries must first be established.

10. Sample description.

    (a) How many people/communities will be involved?

    - Approximately 16 to 20 graduate and/or undergraduate students from the University of Alberta will be screened to generate 8 to 12 trained sensory panelists. Panelists from the previous year's panel will be asked to participate again and panelists from past trained panels will be contacted.

    (b) Describe the characteristics of your sample (inclusion/exclusion criteria)?

    - Trained panel inclusion criteria will be:
        - Screened for higher than average sensory acuity, ability to work in a group and strong verbal skills.
        - Available to attend daily training and evaluation sessions ,up to one hour each, Monday to Thursday, for a duration of 4 weeks in July/August 2003
        - No sensitivities, intolerances or allergies to saskatoon berries or unsalted crackers.

    (c) How are potential participants being recruited or contacted? Attach text of recruitment notice if used as well as the text of the (written or oral) request to participate.

    - Participants for the trained panel will be recruited from the graduate and undergraduate pool working at the University of Alberta by way of poster, e-mail and word of mouth. Attached are samples of the poster, e-mail text and verbal text that will be used to recruit panelists.

11. Summarize your methodology and procedures. (Append research instruments, guiding questions etc. as appropriate).

Source of the berries.

Ripe saskatoon berries will be purchased from local commercial berry growers. Berries will be delivered to the sensory lab at the University of Alberta the day of, or following, harvest.

Trained panel evaluation

a. **Screening session**. In order to ensure that panelists have higher than average sensory acuity and the verbal skills required for participation in a trained panel, potential panelists will be invited to attend a screening session. Attached are the forms for the screening session and an outline of what will be said to the potential panelists.

b. **Information and consent**. Before beginning the screening, the potential panelists will also be given a presentation that describes the purpose, objectives, risks and benefits to participation in the trained panel study, and provided with an opportunity to ask questions. Informed consent to proceed with the screening and to participate in the trained panel (if they are eligible) will then be collected. The information and consent forms are attached.

c. **Assessment of the saskatoon berries**. Panelists will attend approximately eight one-hour training sessions in which they will generate an evaluation form to evaluate the odor, flavour and texture of the saskatoon berries. A proposed evaluation form is attached. The evaluation form will then be used in six evaluation sessions in which the panelists evaluate each cultivars three times. Prior to the panel the berries will be washed and air dried. For each cultivar of berry, approximately 50 mL of washed berries will be placed into a 125 mL containers labeled with a three-digit code. The panelists will evaluate the samples in the sensory booths in the Ag-For Centre. They will be provided with unsalted crackers and filtered water for palate cleansing. During training, panelists will also be consuming "reference samples" to help them identify certain attributes in the berries (*e.g.* sucrose solutions for sweetness, strong tea or cranberry juice for astringency). All reference samples will be selected to avoid any food intolerances, sensitivities and allergies that the panelist may have. As well, at the end of each week the panelists will receive a food treat (*e.g.* ice cream, cookies) for their participation. The treat will be selected to avoid food intolerances, sensitivities and allergies.

12. Describe the benefits of the proposed research to the individual/community.
    - Participants in the trained panel benefit as they work part-time as sensory panelists.
    - Alberta saskatoon berry producers will benefit from the knowledge of the way in which the sensory characteristics of the five cultivars differ from each other. This information will then be used in the following years to determine which cultivar of berry is most suitable for the creation of a shelf-life extended fresh product.

13. Describe the risks of the proposed research to the individual/community.
    - There are no risks for the participants of this study other than those normally associated with the consumption of fresh saskatoon berries and unsalted soda crackers or reference foods which will be picked to accommodate the judges. Participants will be instructed not to participate if they have an allergies, intolerance or sensitivities to the aforementioned foods.

14. If compensation is to be offered to the individual or community, provide details and rationale.
    - Participants will be reimbursed for their time with gift certificates ($120) for West Edmonton Mall.

15. How much time will the individual(s) be required to dedicate to the project? (Include travel time if relevant).

- Approximately 17 hours. The screening session will be approximately 1 hour.

16. (a) What provisions are made regarding confidentiality of data and identities?
  - Only the investigators will know the identity of the trained panelists in relation to the participant number. When the data are entered into a spreadsheet, the evaluations are identified by participant number. When the data are analyzed statistically, means are used to represent the evaluations and the participant numbers are dropped.

(b) Who will have access to any data in which individuals are identified?
  - Only the investigators (Wismer, Ozga and Kidd)

17. Consent from agencies or organizations.
  - None required

18. Consent from participants.
  - Consent from the trained panel participants will be collected after the information session. The consent and information forms are attached.

________________________________ Date:

Signature of Principal Investigator

_____Wendy Wismer__________________
Name of Principal Investigator

________________________________ Date:

Signature of Co-Investigator

_______Jocelyn Ozga________________
Name of Co-Investigator

________________________________ Date:

Signature of Co-Investigator

_______Kylie Kidd____________________
Name of Co-Investigator

"The personal information requested on this form is collected under the authority of Section 33c of the Alberta Freedom of Information and Protection of Privacy Act for the purpose of evaluating candidates to determine their eligibility for this scholarship. Questions regarding the collection, use or disposal of this information should be addressed to the HREB Chair, Faculty of Agriculture, Forestry, and Home Economics, 2-14 Ag-For Centre, University of Alberta, Edmonton AB T6G 2P5. Telephone (780)492-4931, Fax (780)492-0097."

5.1.2 Recruitment Poster

Are you a Super Taster?

Fresh Saskatoon Berries

Pass the screening and become an expert on saskatoon berry flavours by participating in a trained panel.

Participants who pass the screening and complete the berry trained panel will receive a **gift voucher for $120** for West Edmonton Mall, and **treats** after each session!

Give it a try! Contact **Kylie** at 492-3833 or **sensory@ualberta.ca**

Department of Agriculture, Food andNutritional Science

Kylie Kidd
Berry Panel 492-3833
sensory@ualberta.ca

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sensory@ualberta.ca

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sensory@ualberta.ca

Kylie Kidd
Berry Panel 492-3833
sensory@ualberta.ca

5.1.3 Verbal and Written Recruitment Text for Trained Panelists

Hello,

Thank you for your interest in my 2005 Saskatoon Berry Trained Panel!!! My name is Kylie Kidd, and this work is part of my Masters thesis.

Here is some information about the trained panel:

The University of Alberta Sensory Lab is once again gearing up to begin the **Saskatoon Berry Profiling Trained Panel** for the summer of 2005, and I would like to invite you to participate in the screening session.

For those that pass the screening, this year the panel will begin the week of July 4th and will run to July 29th. In August, there will also be round table discussions (3-1/2 hour sessions) of modified atmosphere packaged (MAP) saskatoon berries. The first 2 weeks (i.e. approx. 8- 1 hour sessions) will entail training with the already existing reference standards for flavour, aroma and mouthfeel of the saskatoon berries.

The evaluations will be performed on different commercially produced cultivars of saskatoon berries.

The incentives for participating include snacks/treats after each panel and $120 worth of West Edmonton Mall Dollars for those that entirely complete the panel.

If you are interested in participating, screening sessions (APPROX. 30 MINS) will be held Monday, June 27th and Tuesday, June 28th between 10am and 4pm in the sensory lab (2-35 AG/FOR). Please specify a time that would work well for you. If these dates do not fit into your schedule, individual appointments can be arranged.

If you require further information regarding the panel, please contact me at sensory@ualberta.ca or 492-3833.

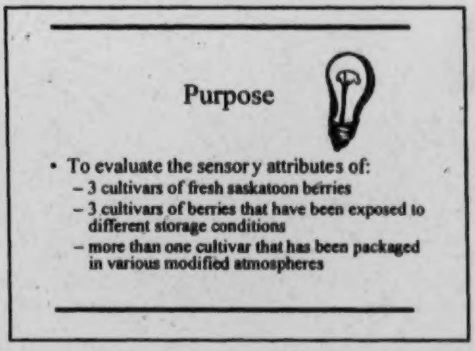
I look forward to hearing from you!!!!

Kylie :)

5.1.4 Screening Presentation

Welcome

to our Screening Session for Trained Panel Evaluation of Saskatoon Berries



Purpose

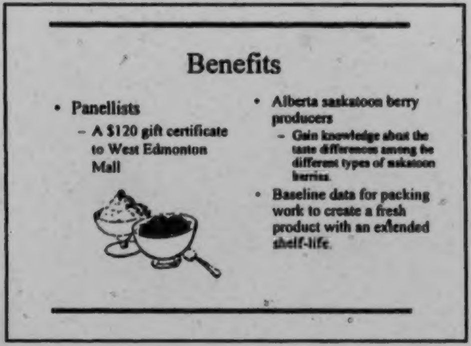
- To evaluate the sensory attributes of:
  - 3 cultivars of fresh saskatoon berries
  - 3 cultivars of berries that have been exposed to different storage conditions
  - more than one cultivar that has been packaged in various modified atmospheres

Methods

- Screening Tests
- Training
  - 8- one hour training sessions
  - 8- half hour evaluation sessions
- All taking place in the Agriculture & Forestry Centre

Confidentiality

- Your name is required on the screening forms
- You will not be asked to put your name on the sensory questionnaires
- Your name and information will only be used if you request a summary of the results and if you indicate that you would like to be contacted for other trained panel opportunities

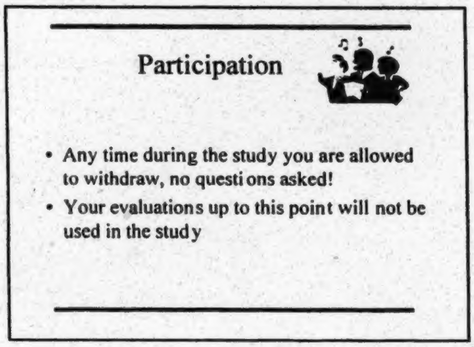


Benefits

- Panellists
  - A $120 gift certificate to West Edmonton Mall
- Alberta saskatoon berry producers
  - Gain knowledge about the taste differences among the different types of saskatoon berries.
- Baseline data for packing work to create a fresh product with an extended shelf-life.

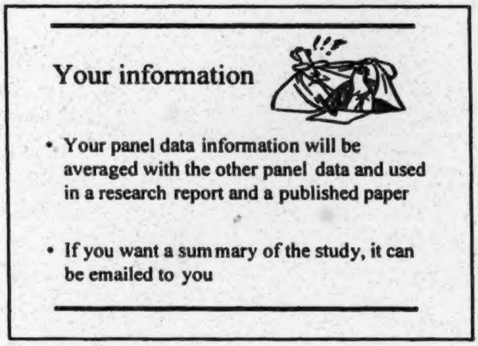
Risks

- PROP (see information sheet)
- Risks involved are no different than those associated with eating fresh saskatoon berries, unsalted soda crackers and water
- Reference standards will be determined by the panel and we will try to avoid any food allergies, intolerances and sensitivities that may be present



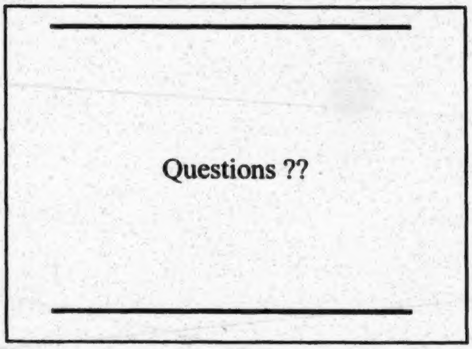
Participation

- Any time during the study you are allowed to withdraw, no questions asked!
- Your evaluations up to this point will not be used in the study

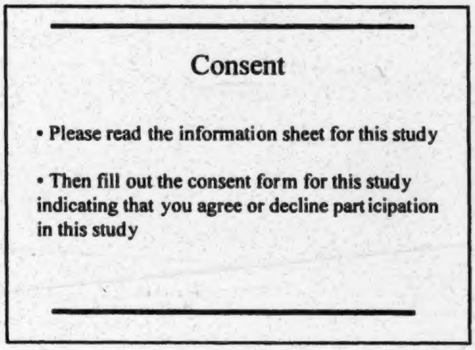


Your information

- Your panel data information will be averaged with the other panel data and used in a research report and a published paper
- If you want a summary of the study, it can be emailed to you

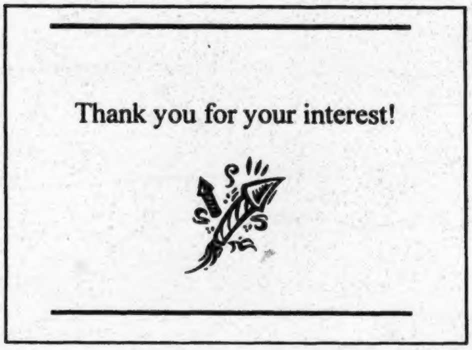


Questions ??



Consent

- Please read the information sheet for this study
- Then fill out the consent form for this study indicating that you agree or decline participation in this study



Thank you for your interest!

5.1.5 Information and Consent Forms

Project Information Sheet: Trained Panel Sensory Evaluation of Saskatoon Berries

Purpose: The purpose of this project is to evaluate the sensory attributes of three cultivars of fresh saskatoon berries, three cultivars of berries that have been exposed to different storage conditions and more than one cultivar that has been packaged in various modified atmospheres.

Screening Session Methods: For the screening portion of this project you will be asked to taste solutions with specific concentrations of caffeine, sucrose, citric acid, salt and distilled water. The next screening test will consist of different sucrose concentrations. In the third test, you will be asked to describe key characteristics of saskatoon berry juice and in the fourth test 6-thiopropyluracil will be tasted to determine if you have super tasting abilities. The fifth test will involve odor identification and a written evaluation that will not involve tasting. If you don't meet specific requirements for the screening tests then you will have no further involvement with this study. This doesn't mean that you cannot enjoy food, it just means that your focus on food is not specific enough for this study, however, we welcome your participation in our consumer taste tests. If you are interested in being on the list of consumer tasters please leave your name and email address or phone number for notification of upcoming studies.

Trained Panel Methods: You are being asked to participate in a trained sensory panel to evaluate three cultivars of saskatoon berries (see purpose section). The training phase of the panel is expected to last for eight-one hour sessions. The evaluation phase will last for eight-half hour sessions. All will take place here at the Agriculture and Forestry Centre at the University of Alberta.

Confidentiality: You will be asked to provide your name on the screening forms, but only your participant number will be asked for on the sensory questionnaires during training. If you wish to be contact about the outcome of the study or would like to participate in future panels, provide your information on the consent form. If you do not pass the screening session your consent forms will be kept confidential and then destroyed at the end of the study.

Benefits: The results of this study may not have any direct benefits for you, although you will be reimbursed for your time with $ 120 in the form of gift certificates should you qualify to participate in the trained panel. There is no payment for the screening session. The results from this study will be valuable to Alberta Saskatoon berry producers who are trying to expand the fresh market for their berries.

Risks: The risks during the screening portion are no different from the normal risks associated with the consumption of products containing sucrose, salt, citric acid, caffeine, water, as well as 15 mL of a solution of 0.0032M of 6-thiopropyluracil (PROP) (8.17 mg), which will not be swallowed. PROP is a compound used to treat hyperthyroidism in doses from 150 to 500 mg/day. To a normal healthy person the amount of PROP solution that could possibly be swallowed in this project would have no side effects. **However, if there is any chance that you are pregnant, you are lactating, or you have a thyroid condition you should not participate in the screening session.**

The risks for the participants in the trained panel portion of this research are no different from the normal risks associated with the consumption of fresh saskatoon berries, water and unsalted crackers, and reference foods determined by the trained panel. Reference foods will be selected to avoid panelist allergies, insensitivities or intolerances.

Withdrawal from the Study: Even after you have agreed to participate in the trained panel, you can change your mind at any time before or during the evaluations and withdraw from the panel. The researchers will not use any evaluations you have completed to that point.

Use of Your Information: This study is being done by researchers in the Department of Agricultural, Food and Nutritional Science at the University of Alberta. Your trained panel data will be averaged with those of the other participants and these mean values will be used to generate a descriptive profile of the taste and texture characteristics of fresh saskatoon berries. The basic berry profile information will be used in the next two years as we compare different methods of packaging the berries to best preserve the fresh flavour.

Aggregate evaluations from the trained panel will be incorporated into research reports for the Alberta Saskatoon berry producers and Alberta Agricultural industries. The data will also be incorporated into a journal publication. If you want, a summary of the research results will be e-mailed to you.

For further information you can contact:

Wendy Wismer	Jocelyn Ozga	Kylie Kidd
492-2923	492-2653	492-3833
wendy.wismer@ualberta.ca	jocelyn.ozga@ualberta.ca	sensory@ualberta.ca

For information about how this project is carried out you may contact:

Georgie Jarvis
Research Ethics Board Administrator
2-14 Ag/For Centre, University of Alberta
492-8126
georgie.jarvis@ualberta.ca

Consent Form for Trained Panel Sensory Evaluation of Saskatoon Berries

Title of Research Project:

Trained Panel Sensory Evaluation of Saskatoon Berries

Investigators:

- Wendy Wismer, Department of Agricultural, Food and Nutritional Science, University of Alberta
- Jocelyn Ozga, Department of Agricultural, Food and Nutritional Science, University of Alberta
- Kylie Kidd, Trained panel leader (MSc. Candidate), Department of Agricultural, Food and Nutritional Science, University of Alberta

Consent: Please circle your answers:

Do you understand that you have been asked to be in a research study?	Yes	No
Is there any chance that you are pregnant or have a thyroid condition? *If you have answered "yes", please stop and tell the panel leader immediately.*	Yes	No
Do you have any allergies, sensitivities or intolerances to saskatoon berries or unsalted crackers? *If you have answered" yes", please stop and tell the panel leader immediately.*	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research study?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
Do you understand that you can quit taking part in this study before or while you are completing this form? You do not have to say why.	Yes	No
Has confidentiality been explained to you?	Yes	No
Do you understand who will have access to your data?	Yes	No
Do you know what the information will be used for?	Yes	No
Do you give your consent to use the data obtained in this experiment for the explained purpose of the study, outlined in the project information sheet?	Yes	No
Do you consent to the use of your data for further analysis at a later date?	Yes	No

The persons who may be contacted about the research are:

Wendy Wismer, University of Alberta, 780- 492-2923
Jocelyn Ozga, University of Alberta, 780-492-2653
Kylie Kidd, University of Alberta, 780-492-3833

This study was explained to be by: ______________________________

I agree to take part in this study.

______________________ ____/____/______

Signature of Research Participant Date (dd/mm/yyyy)

____

Printed Name

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

____

Signature of Investigator or Designee

Summary of the research results:

Would you like to receive a summary of the results of the trained panel research? Yes No

If you would like a summary of the results, please print your e-mail address below. Your email address will not be used for any other reason than to send you the summary of the research results.

e-mail address: ______________________________

Participation in future trained panel evaluations:

From time to time we perform trained panels on a variety of food products. If you would like to be contacted for potential participation in these panels, please provide contact information below
Email: ______________________________
OR
Phone number: ______________________________

For further information you can contact:

Wendy Wismer	Jocelyn Ozga	Kylie Kidd
492-2923	492-2653	492-3833
wendy.wismer@ualberta.ca	jocelyn.ozga@ualberta.ca	sensory@ualberta.ca

5.1.6 Screening Procedure

The volunteers will come into room 2-35 where I will introduce my self, thank them for taking the time to help us out and explain that if there are any insensitivities, allergies or intolerances to caffeine, sucrose, salt, citric acid, water and/or unsalted soda crackers then they should not participate. There are a few tests that the volunteers will have to complete to see if they qualify as trained panelists. The procedures for the tests listed below are described on the attached forms.

a) The first screening test assesses the ability of the panel members to identify the basic tastes. The test will consist of 20mls of the basic taste solutions (sweet, sour, salty and bitter) plus water presented in 30ml cups.

The concentrations of the solutions are:

Caffeine (bitter)	0.2g/L
Sucrose (sweet)	20g/L
Salt (salty)	2.0g/L
Citric acid (sour)	0.8g/L
Distilled water (control)	20 mL

b) The second screening test assesses the participant's ability to discriminate among and rank different concentrations of a solution. The test will consist of ranking 5 solutions (20ml in 30ml cups) of different concentrations of sucrose (2, 5, 7.5, 10 and 12% sucrose concentrations).

c) The third screening test assessed the participant's ability to describe the sensory characteristics of a sample of saskatoon berry juice (20 mL).

d) Determination of taster status (as advertised on recruitment poster) is the third screening test which will be the PROP test using 15 mL of prop solution (6-thiopropyluracil) at a concentration of 0.0032M.

e) The fourth screening test is a two part questionnaire. The first part of the questionnaire asks for panelist availability, food intolerances, sensitivities or allergies and dislikes, and their descriptive abilities related to food. The next section of the questionnaire requires them to quantify the shaded portion of a geometric shape (ability to estimate proportions).

At the end of the screening session participants will be thanked for their participation and will be offered a candy and told that within the next couple of days they will be notified if they have passed the screening.

5.1.7 Screening Scorecards and Questionnaire

5.1.7.1 Basic Tastes Identification Scorecard

Basic Taste Identification Scorecard

Name: ____________________ Date: ___________

On the tray there are five water solutions; four each of the basic tastes plus one of water.

Please taste the samples in the order indicated. **DO NOT SWALLOW THE SAMPLES.** "Swish" the samples around the mouth, then expectorate into the large colored cup provided. Identify the taste you experience. Rinse your mouth with water between samples and wait 30 seconds before proceeding to the next sample. Continue testing in the same manner until all samples have been tasted. Record your initial reaction and **DO NOT** go back to re-taste or change your answer.

Sample Code	*Identity*

Thank you!

5.1.7.2 Sweet Solution Ranking Scorecard

Ranking of Sweetness Intensity

Name: ____________________ Date: __________

Please evaluate and rank the five samples of sweet solutions in water according to their intensity of sweetness. Rank the samples from least sweet to most sweet.

_______________ Least sweet

____

____

____

_______________ Most sweet

Thank you!

5.1.7.3 Saskatoon Berry Juice Description Scorecard

Saskatoon Berry Juice Description Scorecard

Name: ____________________ Date: ___________

On the tray there is a 20 mL sample of saskatoon berry juice.

Please smell the sample and describe some characteristics of:

1) the aroma

____

____

Now taste the sample. ("Swish" the samples around the mouth, then swallow)

Describe some characteristics of:

2) the flavor

____

____

3) the texture

____

____

Thank you!

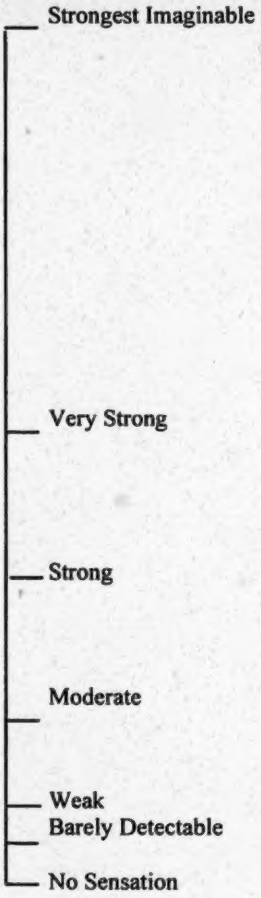
5.1.7.4 PROP Test Scorecard

PROP Test Sensation

Name: ____________________ Date: _____________

Instructions:

1. Cleanse your palate with a sip of water
2. Place the PROP solution provided, in your mouth. **DO NOT SWALLOW THE SOLUTION.**
3. Swish it around in your mouth for ***10*** seconds, ***spit out the solution into the cup provided***, then rate the taste of the solution somewhere between no taste at all ***(no sensation)*** and taste which is the strongest sensation that you could imagine having in your mouth ***(strongest imaginable)***.


Strongest Imaginable
Very Strong
Strong
Moderate
Weak
Barely Detectable
No Sensation

Thank you!

5.1.7.5 Screening Questionnaire

Trained Panelist Screening Questionnaire

Contact information:

Name: ____________________

Phone number (lab/office): ____________________

Email: ____________________

Availability:

1. Are there any weekdays (Tuesday - Friday) that you will not be available between July 5th to July 29th, August 2nd, 9th and 16th?

2. Which time of day would work best in your day to day routine? (circle one)

   - 11:00 am to 12:00 pm
   - 2:00 pm to 3:00 pm
   - other time: ____________________

Health:

1. Do you have any of the following?

   Dentures ________
   Diabetes ________
   Oral or gum disease ________
   Hypoglycemia ________
   Food allergies ________
   Hypertension ________
   Thyroid condition ________
   Pregnant ________

2. Do you take any medications which affect your senses, especially taste and smell?

3. Do you currently smoke? Have you in the past? Please Explain.

Food Habits:

1. Are you currently on a restricted diet? If yes, please explain.

____

2. What is (are) your favorite foods? ________________________

4. What is (are) your least favorite foods? ____________________

5. What foods do you not eat because of sensitivities, intolerances, allergies or dislikes?

Sensitivities → ______________________________
Intolerances → ______________________________
Allergies → ______________________________

6. How would you rate your ability to distinguish smells and tastes?

	Smell	Taste
Better than average	______	______
Average	______	______
Worse than average	______	______

7. Does anyone in your immediate family work for a food company? __________

____

7. Does anyone in your immediate family work for an advertising company or a marketing research agency? ______________________________

____

Flavour Quiz:

1. What are some other foods that taste like yogurt? ________________

____

2. Describe some of the notable flavors in mayonnaise. ________________

____

3. What would you say is the difference between flavour and aroma? __________

____
____
____

4. What would you say is the difference between flavour and texture? __________

____
____
____

Ice Cream Sundae Evaluation

- Imagine you are given unlimited ingredients to make your very own ice cream sundae. Indicate what type of toppings would be on your sundae and what distinctive characteristics you would experience when eating your creation?

- Sundae toppings:

- Important characteristics of the sundae:

5.2 Consumer Panel Forms

5.2.1 Application for Ethics Approval

Faculty of Agriculture, Forestry, and Home Economics

HUMAN RESEARCH ETHICS BOARD

APPLICATION FOR ETHICS APPROVAL

Date Submitted: June 1, 2005

1. Investigator(s).

Wendy Wismer, Kylie Kidd

2. University Department or institutional affiliation (if applicable), phone, FAX, e-mail. Provide this information for each investigator.

Wendy Wismer	Kylie Kidd
Assistant Professor	MSc Candidate
Agricultural, Food and Nutritional Science	Agricultural, Food and Nutritional Science
Ph: 492-2923	Ph: 492-3833
Fax: 492-8914	Fax: 492-8914
wendy.wismer@ualberta.ca	kidd@ualberta.ca

3. Institution(s) through which the Research will be carried out:
   University of Alberta, Agricultural, Food and Nutritional Science

4. Site(s) of data collection

(Survey and Tasting Panels)
- Hole's Greenhouse and Garden Centre, St. Albert, AB

(Survey Only)
- Strathcona Farmers' Market, Edmonton, AB
- Lendrum Sunterra Market, Edmonton, AB
- IGA (location to be determined)

(Focus Groups)
- Locations to be determined

5. Title of Project
- **Consumer evaluation of fresh and stored saskatoon berries.**

(NOTE: There are 3 parts to this project: the survey and tasting panels, survey only panels and focus groups)

6. Source of project funding:
   (X) a granting agency (the AARI Funding Consortium)
   (   ) a company (Please specify)
   (   ) other

7. Anticipated date of commencement of project (Note that items 7-11 should comprise a maximum of 2 pages).
   - It is anticipated that the evaluations will commence late July (July 18 to 31). The exact start date is dependant upon the date of the saskatoon harvest.

8. Purpose and objectives of project
   - The overall purpose of this project is to perform a consumer evaluation of the sensory qualities of three commercially available cultivars of saskatoon berries (Smoky, Northline and Thiessen) that will be evaluated by trained panel (03-12 Trained panel sensory evaluation of Saskatoon berries)
   - The specific objectives of this project are to:
     - determine frequency of fresh berry consumption, common forms of consumption and where fresh berries are acquired by consumers
     - determine consumer perception of modified atmosphere packaging of saskatoon berries and to inquiry about reasonable pricing for this commodity
     - determine consumer preference for the sensory qualities of the commercially available saskatoon berries.
     - evaluate the flavour loss of the berries over 5 days of storage at 4°C, as there is only anecdotal information to substantiate the flavour loss

9. Rationale for this research
   - The saskatoon berry is rapidly gaining importance as a commercial fruit crop on the Canadian prairies. To date saskatoon fruits are not sold in large venues (*i.e.* supermarkets *etc.*) as fresh fruit because flavour and quality of the fruit degrades rapidly within days after harvest. We are working on a project to develop modified-atmosphere packaging to maintain the flavour and texture of the fresh product, which would open up a large fresh market for Alberta saskatoon growers to sell their product. This would greatly stimulate this horticultural industry as markets to sell the fruit are the limiting factor for further growth in this industry. A trained panel (03-12) will be used to characterize the sensory profiles of the fresh berries and follow the changes that result from the modified atmosphere packaging. In this part of the project we would like to determine the commercial cultivar of berry that is most preferred by consumers and the sensory characteristics that are associated with its consumer acceptance. Also, as described above, it is desirable to determine drivers of saskatoon berry consumption and evaluate the flavour of the berry after 4°C storage.

10. Sample description.
    (a) How many people/communities will be involved?
    - Approximately 300 participants are required for the Survey and Tasting Panels.
    - A maximum of 250 participants are required for the Survey Only Panels
    - 10-12 focus group participates are required per focus group session (n=2)

    (b) Describe the characteristics of your sample (inclusion/exclusion criteria)?

- Inclusion criteria will be:
    - Likes fresh saskatoon berries and consumes them at least once per season.
    - No sensitivities, intolerances or allergies to saskatoon berries or unsalted crackers.
    - Aged 18 years or older.
    - Cognitively able to participate with adequate literary skills.

(c) How are potential participants being recruited or contacted? Attach text of recruitment notice if used as well as the text of the (written or oral) request to participate.

- Participants for the survey and tasting panels and the survey only panels will be recruited on location by word of mouth and with a poster outline the project details displayed at the on-site booth (attached). Regarding the survey and tasting panel, in the event the panellist would like to return the following week to participate in the next session, his/her contact information will be take and they will be contacted a day or two before the panel. Focus group participates will be recruited from the survey only participates by word of mouth.

11. Summarize your methodology and procedures. (Append research instruments, guiding questions etc. as appropriate).

Berries

Ripe saskatoon berries will be purchased from local commercial berry growers. Berries will be delivered to the sensory lab at the University of Alberta the day of, or following, harvest. The first delivery of berries will be stored at 4°C for 5 days. A second delivery, two day later, will be stored for 3 days at 4°C. A third delivery of berries will be evaluate that day along will those berries stored for 3 and 5 days at 4°C. Due to the different ripening stages of the saskatoon berries, two different paneling sessions will occur approximately one week apart.

Sensory panel evaluation

- **Information and consent**. Before beginning the survey and tasting panels, the potential panelists will be given a PowerPoint presentation that describes the purpose, objectives, risks and benefits to participation in the consumer panel study, and provided with an opportunity to ask questions. Informed consent to proceed will then be collected. Participants will be invited to attend the two tasting sessions, but it is not a requirement that they attend both. Each participant will then be given a participant number to use as their identifier at each session (the computerized sensory system will prompt them to enter their number so that we can evaluate participant perceptions of the berries over storage conditions). The survey only participates will receive the same information and consent forms with an additional question asking them whether they would be willing to participate in a focus group. For this reason, contact information will need to be taken from those that are interested. The PowerPoint presentation will be made available to the survey only group too. The survey/tasting panel and survey only information and consent forms are attached, as is a printout of the PowerPoint presentations.
- **Assessment of the saskatoon berries**. Survey and tasting panelists will evaluate the appearance, aroma, flavour and texture of the saskatoon berries on the attached form.
- Prior to the panel the berries will be washed and air dried. For each cultivar of berry, approximately 50 mL of washed berries will be placed into a 125 mL container labeled with a three-digit code. The panelists will evaluate the samples in cardboard sensory booth setup on site. They will be provided with unsalted crackers/rice cakes and filtered water for palate cleansing. Following the evaluation, participants will receive a candy.
- The storage conditions will not be specifically described to the participants in order not to bias their perception (*e.g.* less flavour expected of berries stored for one week at 4°C).

- **Demographics, berry use and perception questionnaire.** In the survey and tasting panels, the participants will answer demographic questions, questions about their use of saskatoon berries and willingness to purchase fresh saskatoons. The questionnaire is attached. Consumers (total=250) at different locations (*e.g.* Strathcona Farmers' Market, Lendrum Sunterra Market and an IGA location) representing different market niches for the modified atmosphere packaged saskatoon berry will be asked to complete the same demographic, berry use and perception questionnaire only (survey only group).
- **Focus Group Sessions.** Participates will take part in hour long sessions to gain knowledge about consumer perceptions of modified atmosphere packaged saskatoon berries.

12. Describe the benefits of the proposed research to the individual/community.
    - There are no direct benefits to the participants other then the opportunity to consume fresh saskatoon berries and potentially win a prize.
    - Alberta saskatoon berry producers will benefit from the knowledge of the saskatoon cultivar that is most desired by consumer and their perceptions of modified atmosphere packaging. This information will then be used in the following years to determine which cultivar of berry is most suitable for the creation of a shelf-life extended fresh product.

13. Describe the risks of the proposed research to the individual/community.
    - There are no risks for the participants of this study other than those normally associated with the consumption of fresh saskatoon berries and unsalted soda crackers/rice cakes. Participants will be instructed not to participate if they have an allergies, intolerance or sensitivities to fresh saskatoon berries or unsalted soda crackers/rice cakes.

14. If compensation is to be offered to the individual or community, provide details and rationale.
    - Survey and Survey/Tasting Participants will be offered a candy/snack for their participation.
    - Focus group participates will receive a $10 gift certificate each (store to be determined).

15. How much time will the individual(s) be required to dedicate to the project? (Include travel time if relevant).

    Survey and Tasting Panels
    - Approximately 15-20 minutes per session for each of the cultivar evaluations (if they attend all sessions)

    Survey Only Panels
    - Approximately 5-10 minutes per session

    Focus Groups
    - One hour per session

16. (a) What provisions are made regarding confidentiality of data and identities?
    - Names are not collected with the data. When the data are entered into a spreadsheet, the evaluations are identified by participant number. When the data are analysed statistically, means are used to represent the evaluations and the participant numbers are dropped.

    (b) Who will have access to any data in which individuals are identified?
    - Names are not collected with the data.

17. Consent from agencies or organizations.
    - None required

18. Consent from participants.

- Consent from the participants will be collected after the information session. The consent and information forms are attached.

______________________________ Date:

Signature of Principal Investigator

______Wendy Wismer______________________

Name of Principal Investigator

______________________________ Date:

Signature of Co-Investigator

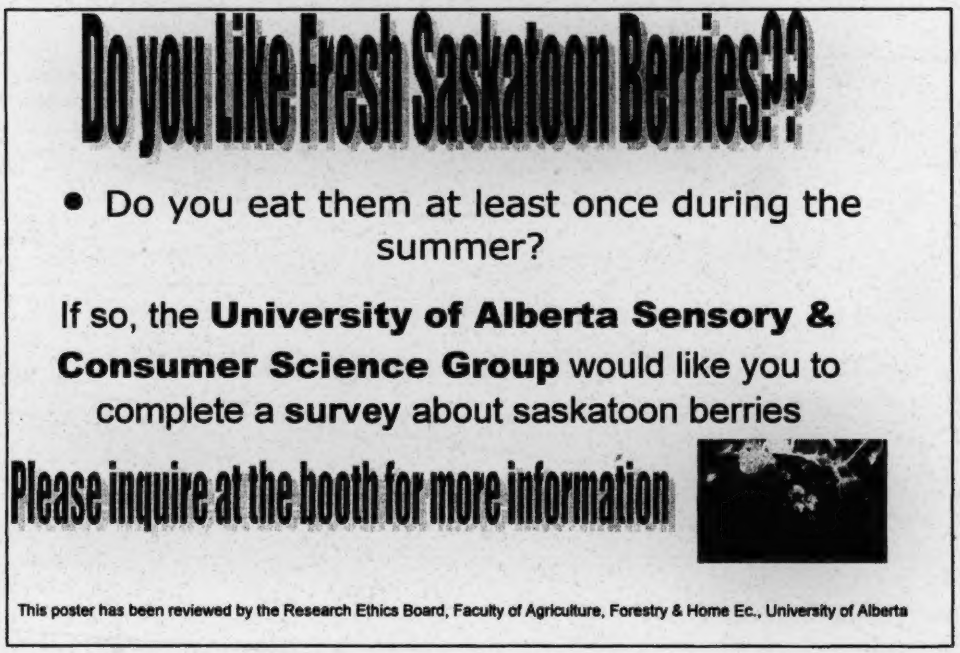
________Kylie Kidd__________________

Name of Co-Investigator

"The personal information requested on this form is collected under the authority of Section 33c of the Alberta Freedom of Information and Protection of Privacy Act for the purpose of evaluating candidates to determine their eligibility for this scholarship. Questions regarding the collection, use or disposal of this information should be addressed to the HREB Chair, Faculty of Agriculture, Forestry, and Home Economics, 2-14 Ag-For Centre, University of Alberta, Edmonton AB T6G 2P5. Telephone (780)492-4931, Fax (780)492-0097."

5.2.2 Survey Only Panel

5.2.2.1 Recruitment Poster



Do you Like Fresh Saskatoon Berries??

- Do you eat them at least once during the summer?

If so, the **University of Alberta Sensory & Consumer Science Group** would like you to complete a **survey** about saskatoon berries

Please inquire at the booth for more information

This poster has been reviewed by the Research Ethics Board, Faculty of Agriculture, Forestry & Home Ec., University of Alberta

5.2.2.2 Verbal Recruitment Text for Consumer Panelists

Hello,

Do you like fresh saskatoon berries? Do you eat them at least once a summer?

If the consumer answers 'yes' to all the questions above…

The University of Alberta Sensory and Consumer Science Group would like to get your opinion about fresh saskatoon berries.

The panel will involve completing a demographic, use and perception survey. The time required to complete the entire evaluation will depend on you. Generally, it should only take 5-10 minutes. Before you can begin the survey, please watch the information presentation on the laptop. This presentation is an overview of the information provide on the information sheet given to you. If you don't have any questions, please fill out the consent form and we can begin.

Once you have completed the survey please help yourself to a candy. Thank you very much for your time. Your opinion is very valuable to both our research and the saskatoon berry producers in Alberta.

If you are interested in participating in a focus group about a packaging method that we are developing to sell saskatoon berries fresh in grocery stores, please write down your contact information on the consent form.

Have a great day and thanks once again!!!!!

5.2.2.3 Information and Consent Forms

Project Information Sheet: Saskatoon Berries Survey

Purpose: The purpose of this project is to gain knowledge about consumer perceptions of saskatoon berries.

Consumer Panel Methods: You are being asked to participate in a consumer survey about saskatoon berries. The survey will take 5-10 minutes to complete and will take place on-site.

Confidentiality: You are not asked to provide your name on the survey. The contact information you provide on the consent form will be used only to inform you of the outcome of the study if you have requested this information and/or to contact you for a focus group session if you would like to participate.

Benefits: The results of this study may not have any direct benefits for you. There is no payment for participating, though you will receive a small incentive. The results from this study will be valuable to Alberta saskatoon berry producers who are trying to expand the market for their berries and to a graduate research project.

Risks: There are no direct risks involved in participating in this survey.

Withdrawal from the Study: Even after you have agreed to participate in survey, you can change your mind at any time before or during its completion and withdraw your participation. The researchers will not use the survey you have completed to that point.

Use of Your Information: This study is being done by researchers in the Department of Agricultural, Food and Nutritional Science at the University of Alberta. Your data will be averaged with those of the other participants and these mean values will be used to generate information about consumer perceptions of saskatoon berries. This data will be published in a graduate student's thesis and a paper publication.

If you want, a summary of the research results will be e-mailed or mailed by post to you.

For further information you can contact:

Wendy Wismer	Kylie Kidd	Jocelyn Ozga
492-2923	492-3833	492-2653
wendy.wismer@ualberta.ca	sensory@ualberta.ca	jocelyn.ozga@ualberta.ca

For information about how this project is carried out you may contact:

Georgie Jarvis
Research Ethics Board Administrator
2-14 Ag/For Centre, University of Alberta
492-8126
georgie.jarvis@ualberta.ca

Consent Form for: Saskatoon Berries Survey

Title of Research Project:

Consumer Panel Sensory Evaluation of Saskatoon Berries Survey

Investigators:

- Wendy Wismer, Department of Agricultural, Food and Nutritional Science, University of Alberta
- Jocelyn Ozga, Department of Agricultural, Food and Nutritional Science, University of Alberta
- Kylie Kidd, Department of Agricultural, Food and Nutritional Science, University of Alberta

Consent: Please circle your answers:

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research study?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
Do you understand that you can quit taking part in this study before or while you are completing the questionnaires? You do not have to say why.	Yes	No
Has confidentiality been explained to you?	Yes	No
Do you understand who will have access to your data?	Yes	No
Do you know what the information will be used for?	Yes	No
Do you give your consent to use the data obtained in this experiment for the explained purpose of the study, outlined in the project information sheet?	Yes	No
Do you consent to the use of your data for further analysis at a later date?	Yes	No

The persons who may be contacted about the research are:

Wendy Wismer, University of Alberta, 780- 492-2923
Jocelyn Ozga, University of Alberta, 780- 492-2653
Kylie Kidd, University of Alberta, 780-492-3833

This study was explained to be by: ______________________________

I agree to take part in this study.

______________________________ ____/____/______
Signature of Research Participant Date (dd/mm/yyyy)

____
Printed Name

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

____
Signature of Investigator or Designee

Summary of the research results:

Would you like to receive a summary of the results?	Yes	No
Would you like to participate in a focus group about packaging of saskatoon berries to allow producers to sell their product in mainstream grocery stores? (the date will be determined based on participate availability)	Yes	No

If you would like a summary of the results or would like to participate in a focus group please print your e-mail or mailing address below. Your email/mailing address will not be used for any other reason than to send you the summary of the research results and/or to contact you for the focus group in you are interested. Please provide your phone number if it is a best way to contact you for the focus group.

phone number: ______________________________
e-mail address: ______________________________
OR mailing address: ______________________________
____

5.2.2.4 Demographic, Use, and Opinion Survey

Participant #:__________

Consumer Demographics and Saskatoon Berry Use Questionnaire

Please take a few moments to answer some questions about yourself and your use and perception of saskatoon berries.

1. What is your gender?
   - ☐ Male
   - ☐ Female

2. What is your age range?
   - ☐ 18 years and under
   - ☐ 18 to 25 years
   - ☐ 26 to 35 years
   - ☐ 36 to 45 years
   - ☐ 46 to 55 years
   - ☐ 56 to 65 years
   - ☐ 66-75 years
   - ☐ 76 years and older

3. Please indicate your **household's** taxable income:
   - ☐ less than $35,595
   - ☐ $ 35,596 to $71,190
   - ☐ $71,191 to $115,739
   - ☐ $115,740 to $142,380
   - ☐ more than 142,380

4. Are you the primary 'shopper' in your household?
   - ☐ Yes
   - ☐ No

5. How frequently do you consume **fresh** saskatoon berries in season **(July/August)**?
   - ☐ More than 10 times per season
   - ☐ 6-10 times per season
   - ☐ 3-5 times per season
   - ☐ 1-2 times per season
   - ☐ Never

6. Where do you obtain **fresh** saskatoon berries? (check all that apply)
   - ☐ My own garden
   - ☐ Friend's/Relative's garden
   - ☐ U-pick farm
   - ☐ Farmers' market
   - ☐ Grocery store
   - ☐ In the wilderness
   - ☐ Other (please describe) ________________________________

7. What is the main reason that you eat saskatoon berries? What do you like best about them?

____
____
____

8. In addition to fresh berries, in what other form do you consume saskatoon berries? **(check all that apply)**

☐ Thawed from frozen
☐ In pies
☐ In other baked products
☐ In jams or jellies
☐ As juice
☐ Other (please describe) ________________________

9. Have you purchased fresh saskatoon berries from a grocery store before? (*e.g.* IGA, Save-on-Foods or Safeway)

☐ Yes
☐ No

If YES, please specify where ________________________________

10. How much would you be willing to pay for 300 grams of **fresh** saskatoon berries? (see container)

☐ more than $8.00
☐ $7.00 - $8.00
☐ $6.00 - $7.00
☐ $5.00 - $6.00
☐ $4.00 - $5.00
☐ $3.00 - $4.00
☐ less than $3.00

If saskatoon berries were available at this venue once the season (July/August) had past (1-3 weeks later), would you be willing to purchase them?

☐ Yes
☐ No, please specify why ________________________________

11. What fresh fruit(s) do you eat most frequently in the summer?

____

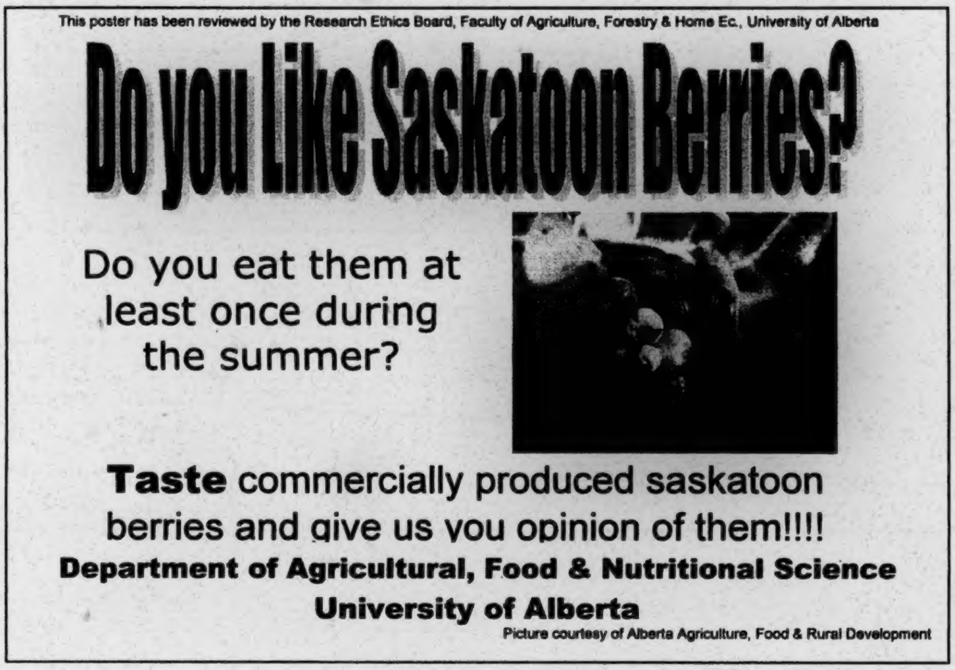
Please provide additional comments below:

____
____

Thank you for answering these questions. Enjoy the Rest of Your Day!!! ☺

5.2.3 Survey and Tasting Panel

5.2.3.1 Recruitment Poster



This poster has been reviewed by the Research Ethics Board, Faculty of Agriculture, Forestry & Home Ec., University of Alberta

Do you Like Saskatoon Berries?

Do you eat them at least once during the summer?

Taste commercially produced saskatoon berries and give us you opinion of them!!!!

Department of Agricultural, Food & Nutritional Science
University of Alberta

Picture courtesy of Alberta Agriculture, Food & Rural Development

5.2.3.2 Verbal Recruitment Text for Consumer Panelists

Hello,

Do you like fresh saskatoon berries? Do you eat them at least once a summer?

If the consumer answers 'yes' to all the questions above...

The University of Alberta Sensory Lab would like to get your opinion about 1 commercially available saskatoon berry cultivar that has been handled differently.

The panel will involve completing a demographic, use and perception survey. The time required to complete the entire evaluation will depend on you. Generally, it should only take 10-15 minutes. Before you can begin the survey, please watch the information presentation on the laptop. This presentation is an overview of the information provide on the information sheet given to you. If you don't have any questions, please fill out the consent form and we can begin.

Once you have completed the survey please have a seat at this table and taste the saskatoon berries. Please remember, there are no right answers, we are solely interested in your opinion. Please also keep in mind, these berries are not 'wild' rather they are commercially available so when evaluating do not use 'wild' berries as a frame of reference to rate them.

Thank you very much for your time. Your opinion is very valuable to both our research and the saskatoon berry producers in Alberta.

Have a great day and thanks once again!!!!!

5.2.3.3 Information and Consent Forms

Project Information Sheet: Consumer Panel Sensory Evaluation of Saskatoon Berries

Purpose: The purpose of this project is to evaluate the sensory attributes of one commercially available saskatoon berry cultivar that has been subjected to different handling techniques. Please note, these berries are not 'wild' saskatoon berries.

Consumer Panel Methods: You are being asked to participate in a consumer sensory panel to evaluate saskatoon berries. The panel will last for one 10-15 minute session (today) and you are welcome to participate in the sessions next weekend. All will take place here at Hole's Greenhouse and Garden Centre.

Confidentiality: You are not asked to provide your name on the sensory questionnaires, only your participant number. The contact information you provide on the consent form will be used only to inform you of the outcome of the study if you have requested this information and to contact you for participation in next week's panel if you are interested.

Benefits: The results of this study may not have any direct benefits for you. The results from this study will be valuable to Alberta saskatoon berry producers who are trying to expand the market for their berries and to the completion of a graduate student research project.

Risks: The risks are no different from the normal risks associated with the consumption of saskatoon berries, unsalted soda crackers/rice cakes, and distilled water.

Withdrawal from the Study: Even after you have agreed to participate in the consumer panel, you can change your mind at any time before or during the evaluations and withdraw from the panel. The researchers will not use any evaluations you have completed to that point.

Use of Your Information: This study is being done by researchers in the Department of Agricultural, Food and Nutritional Science at the University of Alberta. Your consumer panel data will be averaged with those of the other participants to see which cultivars are preferred. The data will also be included in a graduate thesis and a published paper.

If you want, a summary of the research results will be e-mailed or mailed by post to you.

For further information you can contact:

Wendy Wismer	Kylie Kidd	Jocelyn Ozga
492-2923	492-3833	492-2653
wendy.wismer@ualberta.ca	sensory@ualberta.ca	jocelyn.ozga@ualberta.ca

For information about how this project is carried out you may contact:
Georgie Jarvis
Research Ethics Board Administrator
2-14 Ag/For Centre, University of Alberta
492-8126
georgie.jarvis@ualberta.ca

Consent Form for Consumer Panel Sensory Evaluation of Saskatoon Berries

Title of Research Project:

Consumer Panel Sensory Evaluation of Saskatoon Berries

Investigators:

- Wendy Wismer, Department of Agricultural, Food and Nutritional Science, University of Alberta
- Jocelyn Ozga, Department of Agricultural, Food and Nutritional Science, University of Alberta
- Kylie Kidd, Department of Agricultural, Food and Nutritional Science, University of Alberta

Consent: Please circle your answers:

Do you understand that you have been asked to be in a research study?	Yes	No
Do you have any allergies, sensitivities or intolerances to saskatoon berries or unsalted crackers? *If you have answered" yes", please stop and tell the panel leader immediately.*	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research study?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
Do you understand that you can quit taking part in this study before or while you are completing the questionnaires? You do not have to say why.	Yes	No
Has confidentiality been explained to you?	Yes	No
Do you understand who will have access to your data?	Yes	No
Do you know what the information will be used for?	Yes	No
Do you give your consent to use the data obtained in this experiment for the explained purpose of the study, outlined in the project information sheet?	Yes	No
Do you consent to the use of your data for further analysis at a later date?	Yes	No

The persons who may be contacted about the research are:

Wendy Wismer, University of Alberta, 780- 492-2923
Jocelyn Ozga, University of Alberta, 780-492-2653
Kylie Kidd, University of Alberta, 780-492-3833

This study was explained to be by: ____

I agree to take part in this study.

____________________________ ____/____/________
Signature of Research Participant Date (dd/mm/yyyy)

____
Printed Name

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

____
Signature of Investigator or Designee

Summary of the research results:

Would you like to receive a summary of the results of the consumer panel research?	Yes	No
Would you like to participate in the fresh saskatoon berry evaluations next week?	Yes	No

If you would like a summary of the results or would like to participate in the panel next week please print your e-mail address below. Please provide your mailing address if you do not have access to email. Your email/mailing address will not be used for any other reason than to send you the summary of the research results. Please provide your phone number if it is a best way to contact you for next week's panel.

phone number: ____
e-mail address: ____
OR mailing address: ____
____

5.2.3.4 Demographic, Use, and Opinion Survey

Participant #:__________

Consumer Demographics and Saskatoon Berry Use Questionnaire

Please take a few moments to answer some questions about yourself and your use and perception of saskatoon berries.

1. What is your gender?
   - ☐ Male
   - ☐ Female

2. What is your age range?
   - ☐ 18 years and under
   - ☐ 18 to 25 years
   - ☐ 26 to 35 years
   - ☐ 36 to 45 years
   - ☐ 46 to 55 years
   - ☐ 56 to 65 years
   - ☐ 66-75 years
   - ☐ 76 years and older

3. Please indicate your **household's** taxable income:
   - ☐ less than $35,595
   - ☐ $ 35,596 to $71,190
   - ☐ $71,191 to $115,739
   - ☐ $115,740 to $142,380
   - ☐ more than 142,380

4. Are you the primary 'shopper' in your household?
   - ☐ Yes
   - ☐ No

5. How frequently do you consume **fresh** saskatoon berries in season **(July/August)**?
   - ☐ More than 10 times per season
   - ☐ 6-10 times per season
   - ☐ 3-5 times per season
   - ☐ 1-2 times per season
   - ☐ Never

6. Where do you obtain **fresh** saskatoon berries? (check all that apply)
   - ☐ My own garden
   - ☐ Friend's/Relative's garden
   - ☐ U-pick farm
   - ☐ Farmers' market
   - ☐ Grocery store
   - ☐ In the wilderness
   - ☐ Other (please describe) ________________________________

7. What is the main reason that you eat saskatoon berries? What do you like best about them?

____

____

____

8. In addition to fresh berries, in what other form do you consume saskatoon berries? **(check all that apply)**
   - ☐ Thawed from frozen
   - ☐ In pies
   - ☐ In other baked products
   - ☐ In jams or jellies
   - ☐ As juice
   - ☐ Other (please describe) ____________________

9. Have you purchased fresh saskatoon berries from a grocery store before? (*e.g.* IGA, Save-on-Foods or Safeway)
   - ☐ Yes
   - ☐ No

   If YES, please specify where ____________________

10. How much would you be willing to pay for 300 grams of **fresh** saskatoon berries? (see container)
    - ☐ more than $8.00
    - ☐ $7.00 - $8.00
    - ☐ $6.00 - $7.00
    - ☐ $5.00 - $6.00
    - ☐ $4.00 - $5.00
    - ☐ $3.00 - $4.00
    - ☐ less than $3.00

If saskatoon berries were available at this venue once the season (July/August) had past (1-3 weeks later), would you be willing to purchase them?
- ☐ Yes
- ☐ No, please specify why ____________________

11. What fresh fruit(s) do you eat most frequently in the summer?

____

Please provide additional comments below:

____

____

Thank you for answering these questions. Enjoy the Rest of Your Day!!! ☺

5.2.3.5 Saskatoon Fruit Evaluation Scorecard (One Sample Example)

Panelist #:________

Saskatoon Berry Evaluation Scorecard

You have three coded samples of saskatoon berries in front of you. Evaluate the samples in the order shown below.

Please clear your palate before you begin with a bite of cracker and a sip of water.

Sample ____________

Remove the lid of the container and smell the sample of saskatoon berries.

- **Aroma**

Overall, what is your opinion on the **aroma** of these saskatoon berries?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely

- **Appearance**

Overall, what is your opinion of the **appearance** of these saskatoon berries?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely

Take a "bite" of several berries

- **Flavour**

Overall, what is your opinion of the **flavour** of these saskatoon berries?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely

What is your opinion of the **sweetness** of these saskatoon berries?

☐	☐	☐	☐	☐
Not at all sweet enough		Just about right		Much too sweet

What is your opinion of the **saskatoon flavour** of these saskatoon berries?

☐	☐	☐	☐	☐
Much too weak		Just about right		Much too strong

- **Texture**

Overall, what is your opinion of the **texture** of these saskatoon berries?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely

- **Overall opinion**

Overall, what is your **opinion** of these saskatoon berries?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely

If you have any comments on this sample of saskatoon berries, please record them below:

____

____

____

Please take another bite of cracker and sip of water to clear your palate.